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COMPLEX BURN REGION MODULE (BRM) UPDATE
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16.Abstract

Complex Burn Region Module (CBRM) Update for the Solid Rocket Internal Ballistics Module (SRIBM) Program for the ASRM Design/Performance Assessments. Develop an improved version of the solid rocket internal ballistics module program that contains a diversified complex region model for motor grain design, performance prediction, and evaluation.

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PREFACE

This technical report was prepared by the staff of the Research Institute, The University of Alabama in Huntsville. It documents the research performed under contract NAS8-36955, Delivery Order 51. Mr. Carl Adams and Dr. Billy Jenkins were Principal Investigators. Technical work was accomplished by Billy Jenkins, Mr. Mark Bowden, and Dr. Larry Dunbar. Mr. Douglas Blackwell, Propulsion Laboratory, provided technical coordination.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official National Aeronautics and Space Administration, Marshall Space Flight Center position, policy, or decision unless so designated by other official documentation.

I have reviewed this report, dated Feb. 1991 and the report contains no classified information.

Billy Jenkins
Principal Investigator

Approval:

Terry N. Long
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1. Nature of the Task

The design of solid rocket motors requires the prediction of the burning surface area and the port volume in the motor as a function of burn time. Alternatively, if the grain regression rate is specified, the burnback distance as a function of time can be found and the burning area and port volume calculated in terms of burnback distance, reducing the problem to one of solid analytical geometry.

MSFC has been using the Complex Burning Region Model (CBRM) and the computer code based upon this model since the early 1970s when it was developed for them by Northrop Services specifically to aid in the design of the Revised Solid Rocket Motor (RSRM) referred to today as the SRM. At the present time, a replacement for the RSRM is being designed, the Advanced Solid Rocket Motor (ASRM). The ASRM differs in grain design from the SRM to the extent that the CBRM is no longer adequate to predict its performance. Both the ASRM and the SRM use grain designs wherein, aft of the head dome, a star pattern section is followed by a cylindrically perforated (CP) section with an intermediate transition zone. As presently envisioned, the CP section of the ASRM is not qualitatively different from that of the SRM; it is the star and transition regions which have changed. Figures 1 and 2 contrast the differences between the two motors. Instead of a simple star, as seen in the SRM, the ASRM introduces a compound star wall consisting of three surfaces instead of one (Fig. 1). The transition region, instead of a simple "climb out" from the star valley, widens as it progresses towards the CP region introducing new surfaces (Fig. 2). (Numerical dimensions for nominal cases are given in the appendix.)

This report describes the effort, performed under contract to MSFC, which modifies the CBRM to be applicable to the ASRM and the results achieved. The code produced will be referred to as CBRM-A.

2. Approach

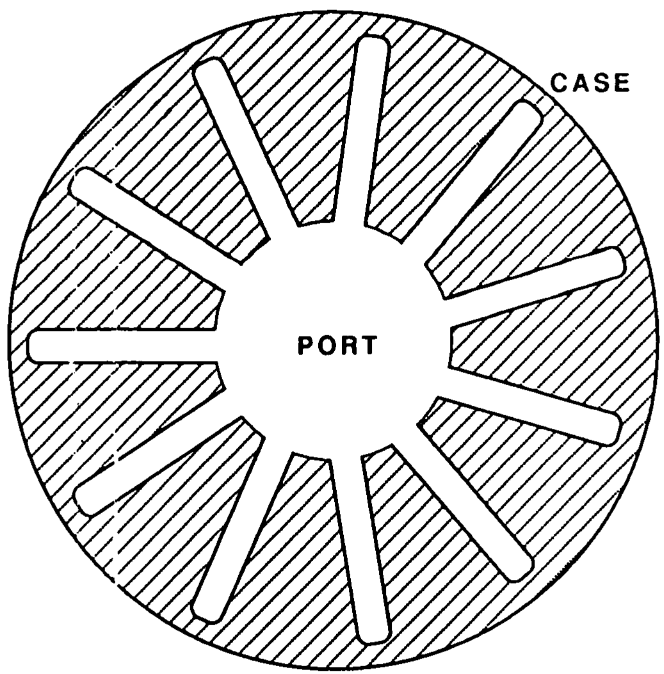
The exact dimensional configuration of the ASRM is subject to change. Consequently, care was taken to insure that the modified CBRM code has the flexibility to correctly calculate burning area and port volume for variations on the ASRM design first provided to UAH in May 1990. This flexibility, and the increase in the number of surfaces, constitute the principal analytical complication introduced by the new grain pattern. Familiarity with the original CBRM documentation (Refs. 1 and 2), terminology, and code will be assumed in this report. CBRM-A was coded to provide for the minimum change in input, output, and program flow from that of CBRM.

a. Extent of the flexibility in CBRM-A.

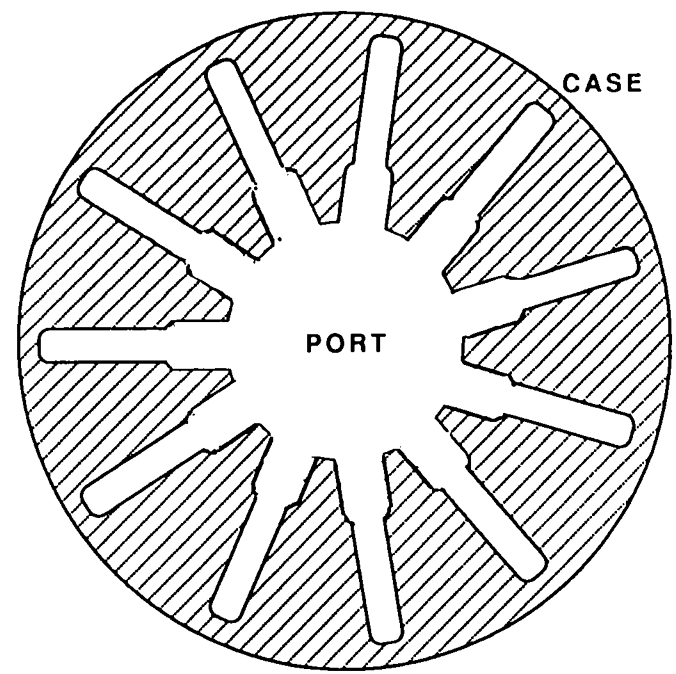
Figure 3 shows the convention used in referring to the star and transition surfaces in the ASRM. Note that as regression proceeds, the concave intersection where S2 and S3 meet will develop into a cylinder. This cylinder will be called CY1. In fact, for coding purposes each of the surfaces has an alternate designation. The section on coding gives the

FIGURE 1

COMPARISON OF RSRM AND ASRM STAR SECTION GRAIN PATTERN



RSRM



ASRM

FIGURE 2

COMPARISON OF RSRM AND ASRM TRANSITION REGION CONFIGURATION

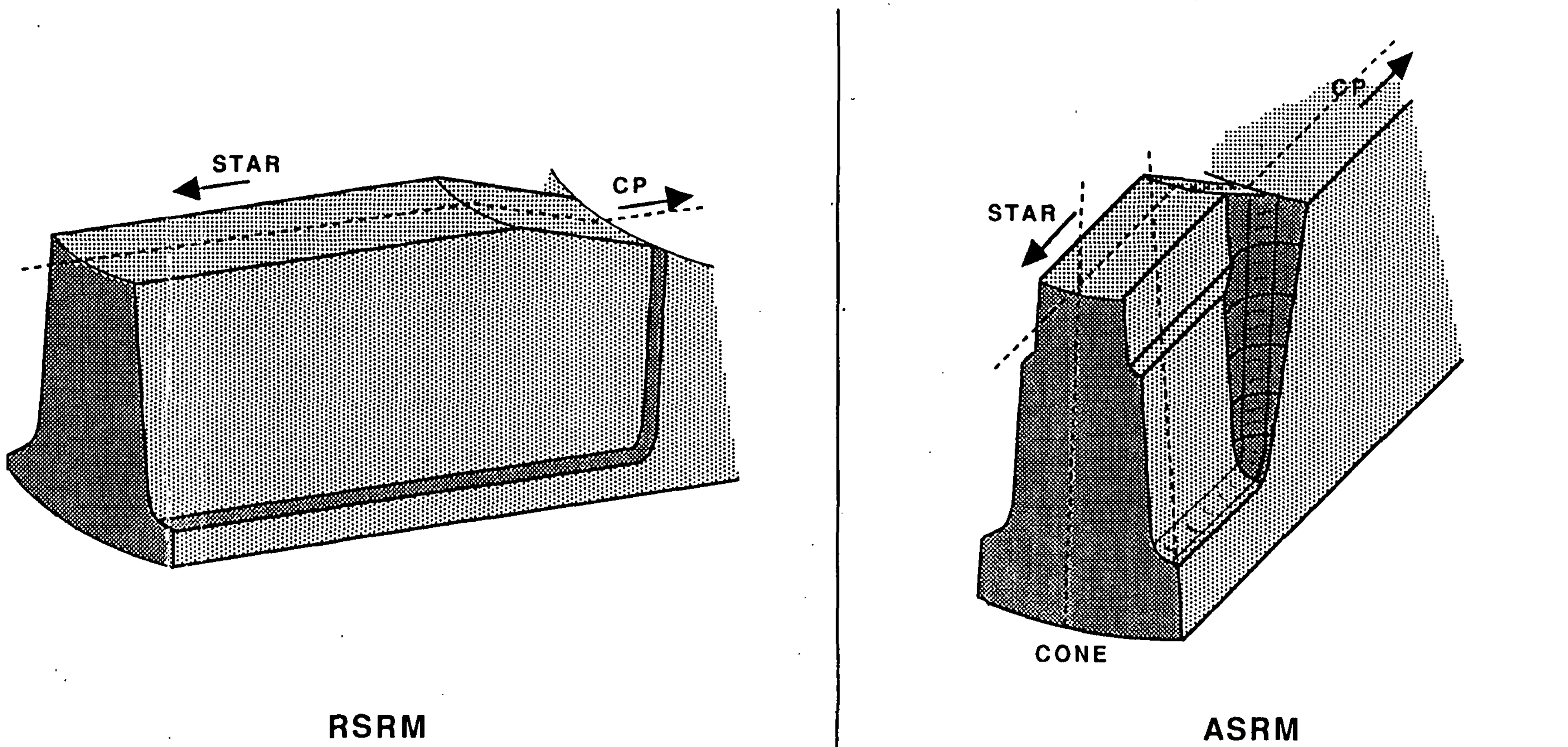
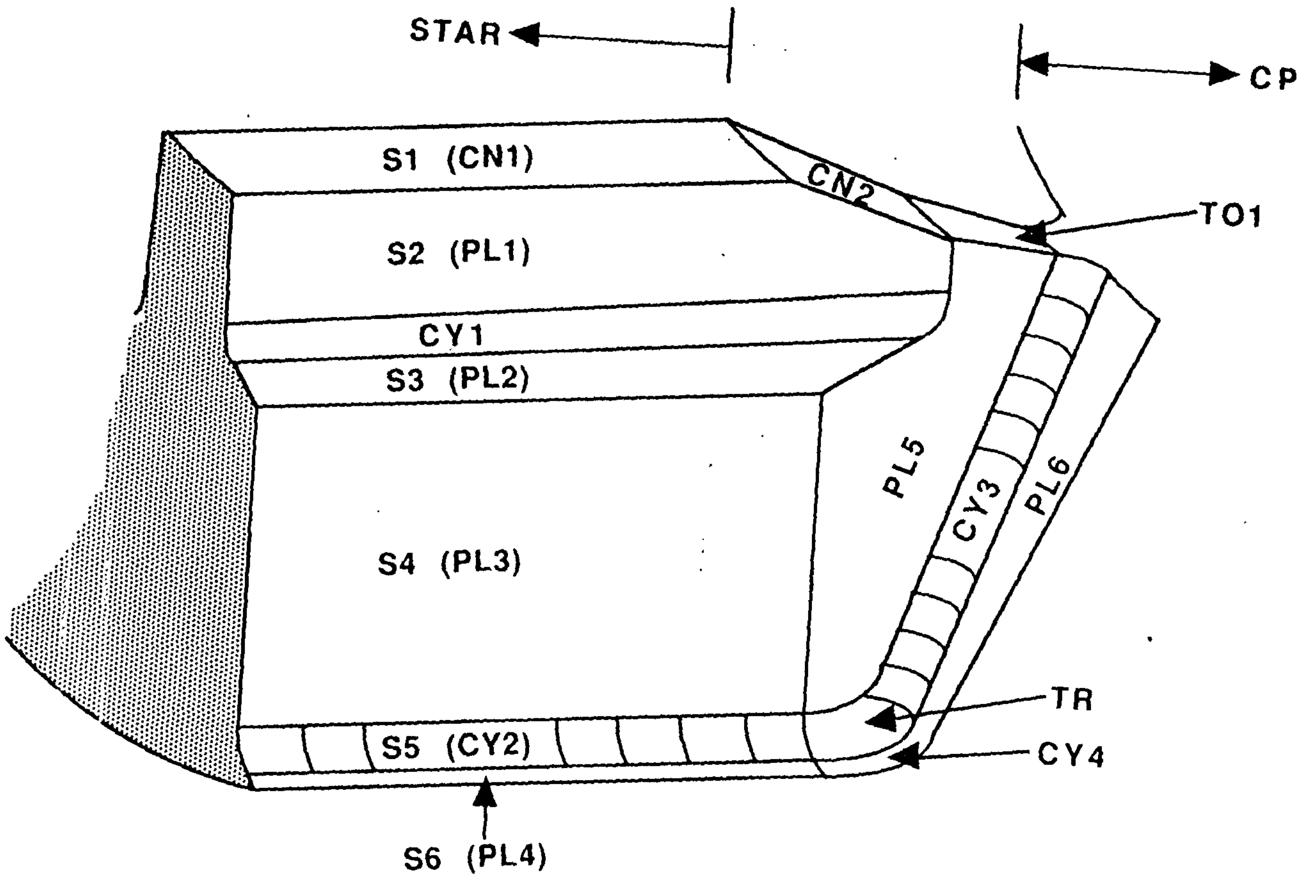


FIGURE 3

DESIGNATION OF SURFACES IN THE STAR AND TRANSITION REGIONS



correspondence between the S-designation and the more descriptive one used in the code. Although the grain configuration shown in the ASRM drawing has the surfaces S2 and S4 parallel to the valley centerline in cross section, it is not necessary for this to be true for CBRM-A. The only constraint is that, before ignition, S2,S3, and S4 be continuous planes throughout the star region. The valley floor, comprised of S5 and S6, need not be (and in the ASRM is not) continuous in this region. If a simple star geometry is desired, the surfaces S2 and S3 can be made null by the proper input. The transition region, on the other hand, must consist of the surfaces as shown in the ASRM drawing, but all angles and dimensions may vary from those shown. In order to benchmark the CBRM-A against the CBRM, it would be necessary to insert code to avoid zero denominators in the computation of the intersection of the star wall surfaces with transition surface S7.

While CBRM appeared to account for burnback rates which were a function of axial station, z, the code did not actually incorporate this. CBRM-A has implemented this feature in the star region.

b. Introduction of new surfaces

The number of possible ways in which surfaces may intersect increases as the factorial of the number of surfaces. The actual computation of the lines of intersection is simple, but the logic to determine the sequence of events during regression becomes quite complicated, particularly if the flexibility mentioned above is to be maintained. The following section, Coding, goes into more detail on this.

c. Surface representation

To facilitate the representation of surfaces, both initally and during the course of burn, standard representations for each class of surface were used which differ somewhat from Ref. 1. In each case, the surface is described by a number of constants, one of which need only have the cumulative burnback distance added to it to account for regression. The same coordinate system is used as in CBRM. The cumulative burnback distance is S_b. The standard representations are as follows:

- Plane (S2, S3, S4, S6, S7, S9)

$\bar{r} \cdot \hat{n} = R_p + S_b$ where $\bar{r} = (x, y, z)$ and $\hat{n}$ is a unit vector normal to the plane in the direction of regression. This becomes $\alpha x + \beta y + \gamma z = R_p + S_b$ where α, β, and γ are the direction cosines of the unit normal, $\alpha^2 + \beta^2 + \gamma^2 = 1$. R_p is the perpendicular distance from the origin to the plane before ignition.

- Cone centered on z-axis (S1, S8)

$x^2 + y^2 = \left(z \tan\alpha_c + \dfrac{R_c + S_b}{\cos\alpha_c}\right)^2$ where α_c is the cone semivertex angle and R_c is the perpendicular distance from the origin to cone surface before ignition. If α_c should be zero, a cylinder results.

- Cylinder (CY1, S5, S11)

$$\frac{\left[Ax + Cy - \left(A^2 + C^2\right)z + (AB + CD)\right]^2}{A^2 + C^2 + 1} + [Cx - Ay + (AD - BC)]^2 = \left(A^2 + C^2\right)(R_{cy} + S_b)^2$$

where the axis of the cylinder is defined by the equations: $x=Az+B$, $y=Cz+D$, and the initial radius of the cylinder is R_{cy} . This equation is not valid if the cylinder axis is perpendicular to the z-axis, as is the case with S10. Axis flexibility is not required of S10 and its equation can be written knowing only its initial radius and its center x and y values. It is worth noting that the equation for the cylinder as given in Ref. 1 is incorrect.

- Torus ringing the z-axis (S12)

$\left(\sqrt{x^2 + y^2} - R_{maj}\right)^2 + (z\text{-}ZTO)^2 = (R_{min} + S_b)^2$ where R_{maj} is the large radius of the torus, R_{min} is the minor radius of the torus, and ZTO is the z-station of the torus (input).

S13 is a sector of an oblate skewed toroid which is better handled without attempting to represent it by an equation.

The user is not expected to supply the constants used to represent the various surfaces. The required input is, for the most part, in terms of quantities given on the ASRM drawings and is cast into the proper form by the code.

3. Coding

a. General comments

The program flow of CBRM-A has not changed qualitatively from that of CBRM. In brief, MAIN (PROGRAM CBRM-A) has been changed to accept the new input (see Appendix A) and the references to incremental dividing planes (IDPs) have been changed to correspond to the new division of the transitional region. Whereas the CBRM called subroutine PLNSET to initialize the grain configuration tables and place the IDPs, an additional subroutine, TRNSET, is called to initialize the transition region. MAIN contains the major loop which increments time and prints the variables of interest as time progresses. The computation of the incremental burning areas and port volumes between IDPs is governed by subroutine BNCTRL. BNCTRL sets the burnback rate (a constant was used in CBRM) for the time increment and calls the appropriate subroutine (STRBRN, TRNBRN, SLTBRN, or CPBURN) to calculate the new cross section at the IDP after regression over the time increment and return the incremental burning areas and port volumes which, through labelled COMMON are passed to MAIN. BNCTRL has only been changed to reflect the changed IDP placement in the transition region. The changes to CBRM-A do not affect any of the burnback routines except STRBRN, TRNBRN and their attendant subordinate routines. These routines will be described later.

Although the CBRM was purported to accept a burnback rate varying with z, the coding to properly treat the resulting uneven regression at each IDP was absent. This has been added to CBRM-A for the star region, although it is inhibited in the compiled version. In MAIN a constant, IBRNCON, is set to zero, causing the program to skip the recomputation

of the surfaces. If IBRNCON is non-zero, this recomputation is carried out, requiring considerably more computation time. No functional form for the dependence of burning rate with z is provided for. When this option is required it will only be necessary to recompile with IBRNCON not equal to zero, specify the dependence of burning rate with z, modify the COMMON block BRNCON to convey this to BNCTRL, and enter the functional form (or table) at the indicated point in BNCTRL.

Supplement 1 to this report is a listing of the CBRM-A including numerous comments to guide the user through the modifications to the code. Those parts of the code dealing with the aft, slot, and CP sections have not been changed. The following list indicates the subroutines eliminated by the modifications, all of which dealt with the CBRM star and transition regions.

SAREA2

FILLET

PSTN1

PSTN2

TRBRN2

SETIDP

The changes to MAIN and BNCTRL have been outlined above. The next list covers the other changed routines, the new routines subordinate to these and a qualitative description of the changes. The comments in the listing in Appendix A will indicate to the reader where these changes occur in the code.

- PLNSET Up to the point where the setting of IDPs in the CP region and at the slots in the CP region begins, this subroutine has been changed completely. The constants for the generalized equation for each of the surfaces in the star region before motor ignition are calculated and set into arrays. In the CBRM, all the variables necessary to describe the star section at each IDP were entered into array CALCON. A new array, STRNU, is used to store the additional parameters necessary to describe the altered star region. For coding purposes, the surface nomenclature used in Figure 3 is changed in the arrays to reflect the type of surface. The correspondence is as follows. The first time a particular type of surface appears (cone, cylinder, or plane), the order of storage of the constants in the arrays is given.

S1 CN1(IDP, K) , K=1 for $alpha_c$, K=2 for R_0

CY1(K), K=1 to 4 for A,B,C, and D; K=5 for R_{cy}

S2 PL1(IDP, K), K=1,2,3 for alpha, beta, and gamma, K=4 for R_p

S3 PL2(IDP, K)

S4 PL3(IDP, K)

S5 CY2(RFPL, K)

S6 PL4(IDP, K)

The above list indicates the subscripts of the arrays. The cones and the planes must be allowed to change for each IDP in case the burnback rate is not constant. Cylinders, on the other hand, do not experience a change in axis or initial radius due to non-constant burning rates. Consequently, CY1 remains constant throughout the star region by the assumption of continuity of surfaces S2 and S3 throughout the star region. CY2, however, may change at intermediate reference planes (RFPL). New subroutines written to support PLNSET include STPTST (to be described later), PLANE and SOLVE which use three given points on the plane surfaces to derive the constants for the PL_ arrays, and KISS and PT20 to solve for the point where a line going through a given point is tangent to a given circle.

- TRNSET This is an entirely new subroutine. PLNSET still sets all the initial IDPs, but TRNSET sets up the constants defining the initial surfaces in the transition region. Some iteration is called for since the information given in the drawing does not allow one to determine the axis of S11 in closed form. Instead, the width of the aft end of the transition is given (WIDCO in the input) along with the z-position of the end of transition and enough information to determine the equation of S9. This, and the cross section at the end of the star section is enough to define S11 in standard form. The other surfaces, save unlucky S13, can then be defined in a straightforward manner. The correspondence between the surfaces as discussed in this report and the arrays containing the standard constants for the surface are as follows:

S7 PL5

S8 CN2

S9 PL6

S11 CY3

S12 TO1(K) K=1 for ZTO, K=2 for R_{maj}, and K=3 for R_{min}

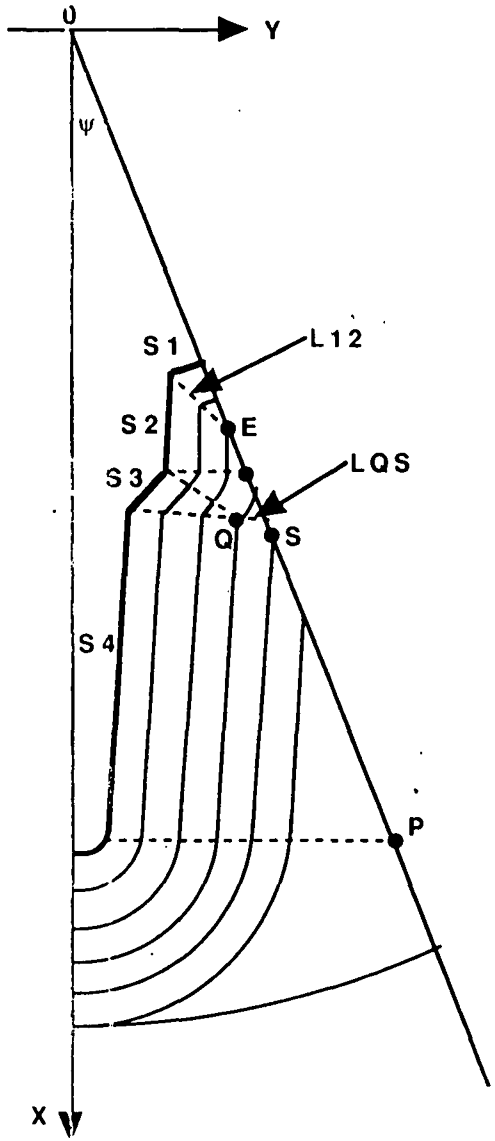
b. Treatment of star region

The star region is treated in much the same manner as it was in CBRM, i.e., subroutine STRBRN calls STRGEO which returns the burning perimeter and port cross-sectional area for the IDP which are then used by STRBRN to find the incremental burning area and port volume between this and the preceding IDP. STRBRN required little change. If IBRNCON is not equal to zero, subroutine SRESET is called to account for the change in the surface equation constants due to non-constant burning.

STRGEO, however, has been entirely changed. In CBRM-A, as regression proceeds, the order of disappearance of surfaces at each IDP is not a priori known. This can be calculated, and is left to the code. Figure 4 shows certain significant points in the course of regression. Point E marks the disappearance of S1, point R the disappearance of S2, point S the disappearance of CY1, point Q the disappearance of S3, and point P the disappearance of

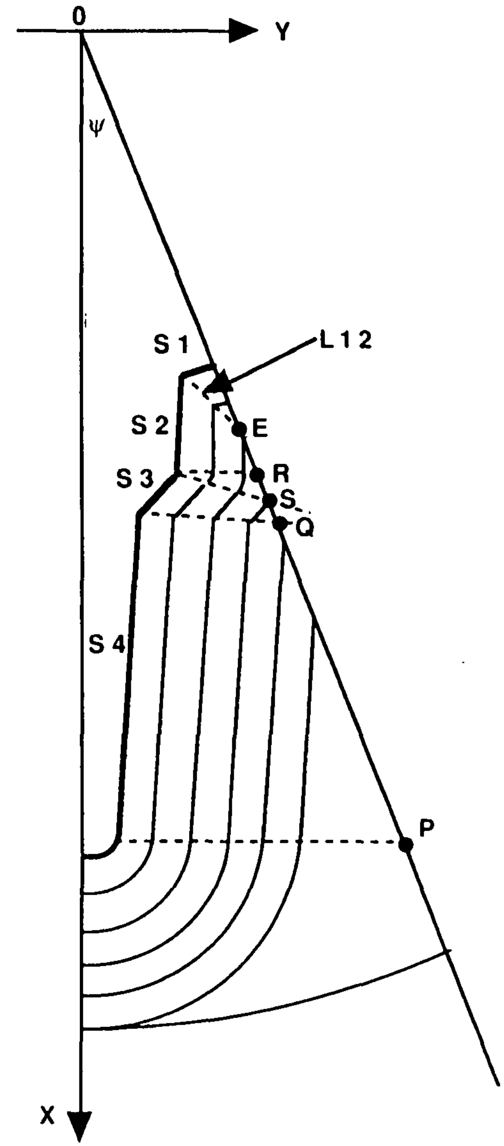
FIGURE 4

SIGNIFICANT REGRESSION POINTS IN A STAR SECTION IDP



4 b

pt E -S1 disappears
R -S2 "
S -CYl "
Q -S3 "
P -S4 "



4 a

S4. The significant points are determined by eliminating the parameter S_b between the equations of each successive pair of surfaces to determine the equation of the burnback line or conic demarcating these surfaces. For example, S1 and S2 can be solved by elimination of S_b, at the z-value for the IDP, to find the burnback parabola L12 (Figure 4). The centerline of the star peak is defined by the line $y = x\tan\psi$. If burnback loci intersect this line of symmetry before intersecting each other, the associated point is located at this intersection (Fig. 4a). But if burnback lines intersect (and hence a surface disappears) before reaching the centerline (examine point Q in figure 4b) then a new burnback line is found for the surviving surfaces surrounding the one which disappeared (the burnback ellipse LQS in figure 4b is an example). A subroutine, STPTST, calculates the position of the points E, R, S, Q, and P as well as the value of S_b corresponding to this point for each IDP. If the burnback rate is constant, STPTST is called only once and this is done from PLNSET. If the burning rate is a function of z, STPTST is also called from STRBRN before calling STRGEO. The data relative to each point is stored in arrays PTE, PTR, etc. These arrays are doubly dimensioned, the first being the IDP and the second 1,2 or 3 corresponding to the x,y, and S_b associated with the point. STRGEO can determine the order and time of disappearance of the surfaces by the values of S_b found in these arrays.

As with CBRM, the z location of the end of the star region changes as burning progresses. The number of the last IDP in the star section is designated MIDPL.

c. Treatment of the transition region

In the CBRM, the transition region was divided by six IDPs into seven different regions, not all of which existed at the same time. These were movable IDPs which tracked such locations as the beginning of the CP region or the most forward point of burnthrough to the case. In recoding for CBRM-A, this proved to be impractical due to the complexity of the geometry. The number of possible configurations which the transition region may take for various orientations of the transition and star surfaces is astronomical if flexibility is to be maintained. Figure 5 shows some of the forms assumed by the transition region as it regresses. Consequently, a less elegant, but equally accurate, method was used. In CBRM, in order to calculate the port volume and burning area in the segment delimited by the torus corresponding to S12 (which was bounded by movable IDPs), a numerical integration was used rather than the general prismatoidal formula. In CBRM-A, a similar approach is used throughout the transition region. The IDP corresponding to the beginning of the CP region is MIDPL+1, so that the entire transition region is contained between the two movable IDPs, MIDPL and MIDPL+1. This region is sliced into parallel layers spaced 0.1 inches with the number of layers determined by the locations of the bounding IDPs. The outline of the remaining exposed propellant grain and outer case in each layer is calculated.

Subroutine TRNSET was called to initialize the planes and bounding IDPs in the transition region. BNCTRL calls TRNBRN, providing it with the accumulated burnback for the transition region. It returns port volume, burn area,and exposed outer case area for the entire transition region.

TRNBRN determines a set of nine key geometric points by calling subroutines P1 through P9. These key points denote intersections of surfaces that compose the transition region. This set is a function of the accumulated burn back and all key points, except P7, are determined by analytically solving three determining surface equations simultaneously. P7,

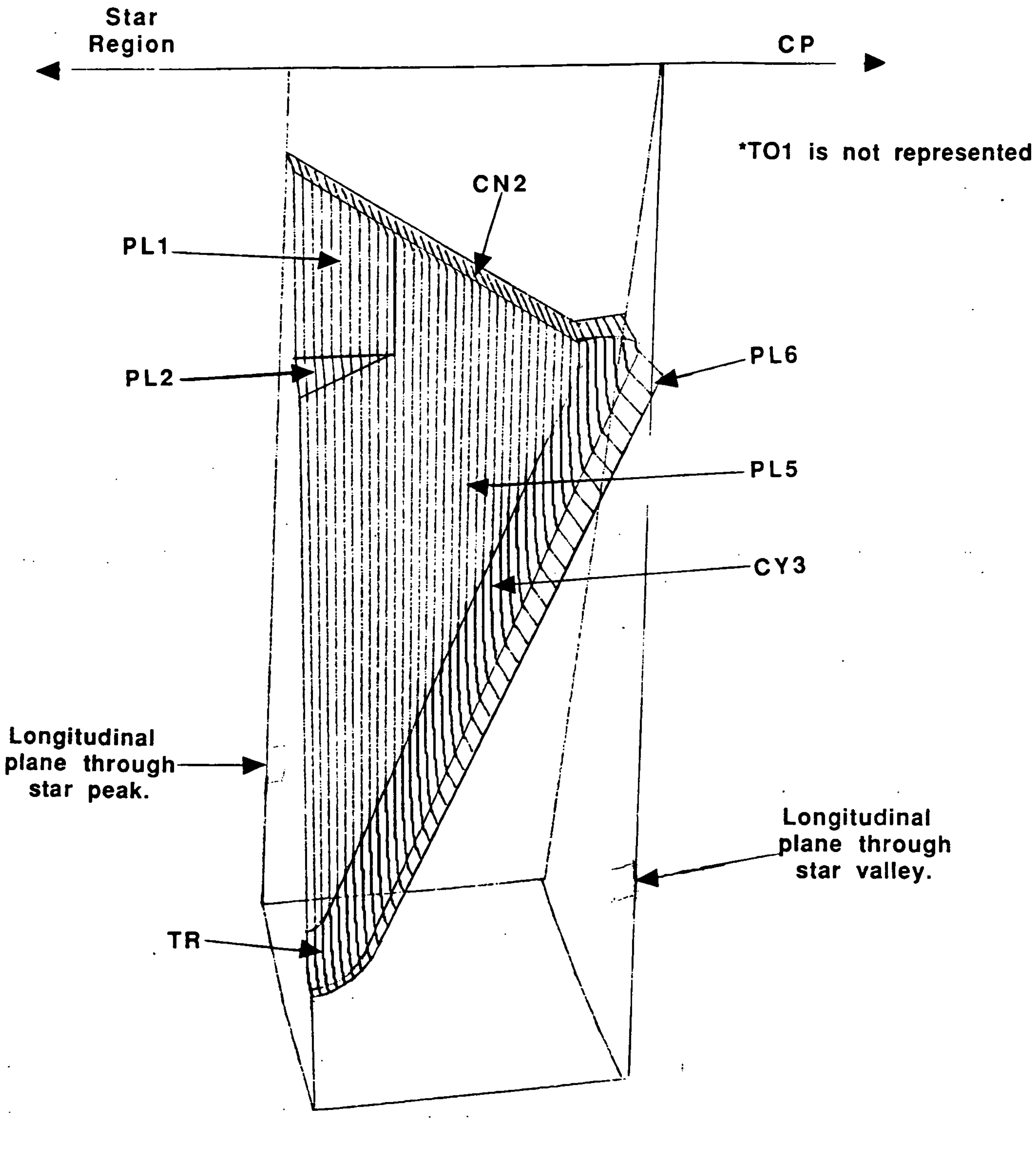


FIGURE 5-a
Transition Region Before Regression

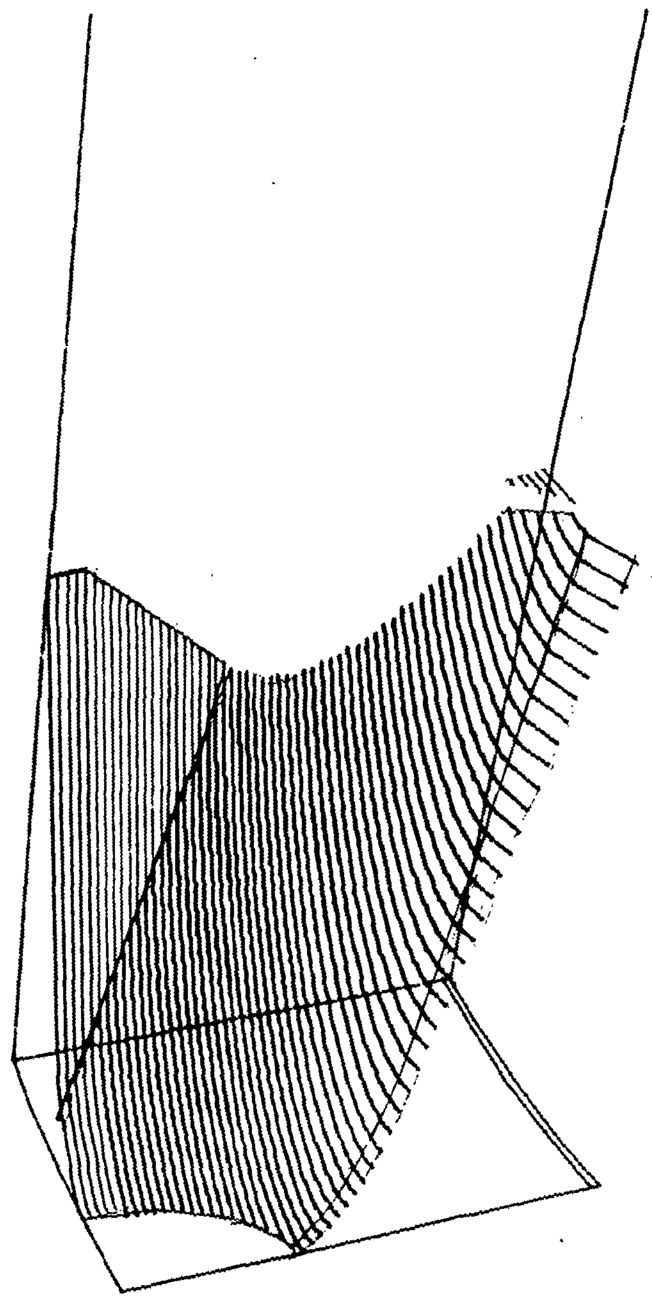


FIGURE 5-b
Transition Region at an Intermediate Stage of Regression

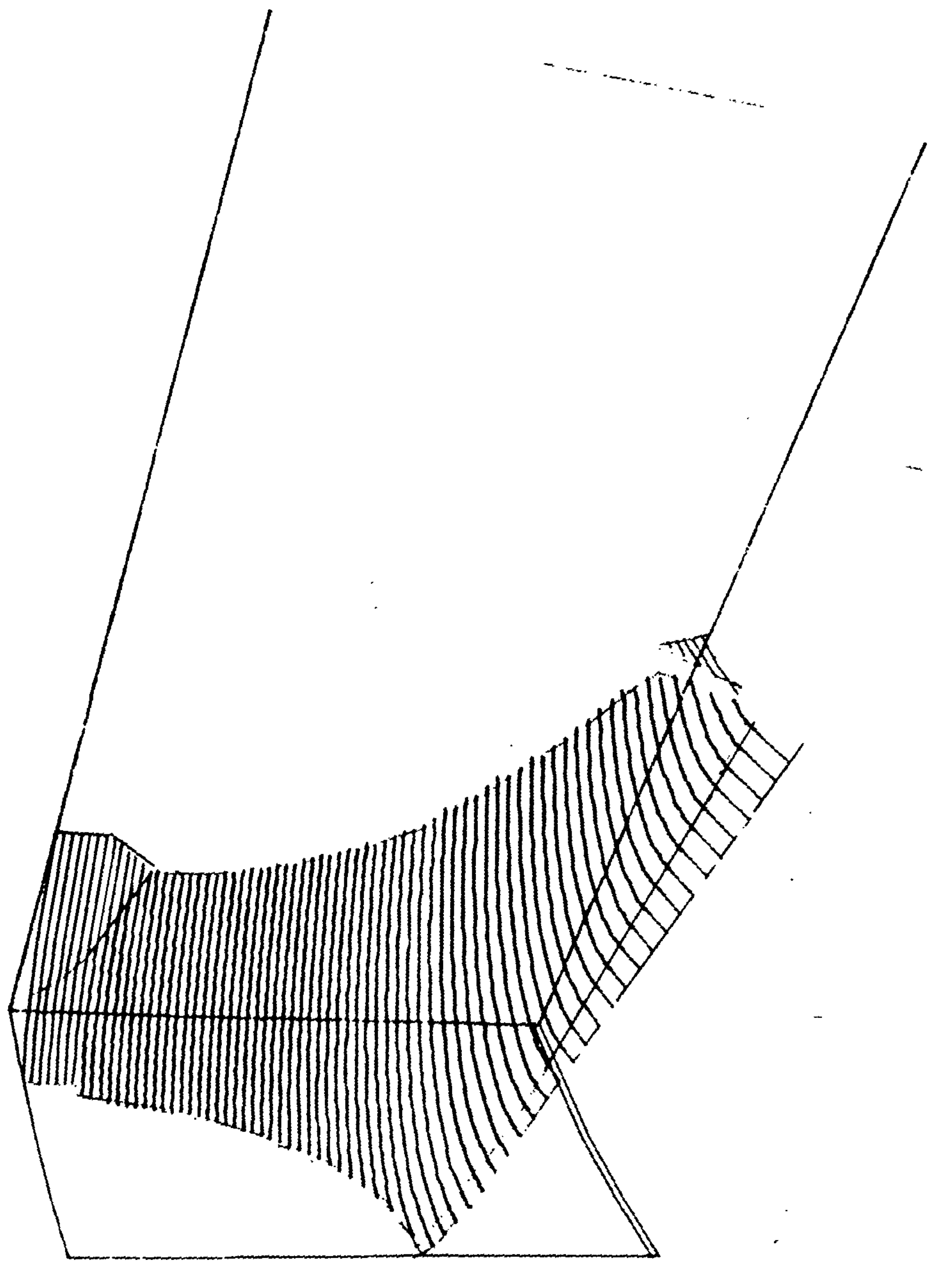


FIGURE 5-c
Transition Region at an Intermediate Stage of Regression

which is specified in part by a toroidal surface, is determined numerically by sequential testing the axial coordinate at small steps of 0.1 inches. The two off-axial coordinates are determined by analytically solving the determining surface equations.

For each layer, subroutines TS1 through TS13, one for each surface, determine two limits by geometrically correct interpolation algorithms based on the key point set, geometric limits of the outer case and the line of symmetry of the star peak [$y=x\cdot\tan(\psi)$]. The distance between these paired limits specifies the contribution to the outline of the grain. This value is stored in array TS(_). An additional limit point is determined that specifies the surface boundary with the exposed case. The distance between this point to the star valley centerline is the outline of a layer at the outer case. This value is stored in array TC(_). The burnback area and outer case area are determined by numerical integration of the outline of the grain and outer case for each layer across the transition region. Port volume, in turn, after the initial volume is determined by numerical integration in subroutine PORTV, is determined sequentially by numerical integration of burn area for repeated calls of TRNBRN.

TRNBRN also provides the z-values of MIDPL and MIDPL+1, separating the transition from star region and the transition from the CP region, respectively.

In the current implementation of the program, the torus S12 is not represented but the cone CN2 and the CP port are assumed to join without a fairing transition (see figure 5). Moreover, an approximate relation is used to represent the surface S13 in order to facilitate solution of its intersection with other surfaces.

4. Results

CBRM-A has been run using the most recent version of the ASRM geometry and compared with manual calculations of the intial port volume and burning area in the star and transition regions. The appendix describes the input to this sample case. In order to assess the limitations of the code, the parameters defining the geometry were varied within reasonable bounds. The results of these robustness studies are described in supplement 2 to this report.

Figures 6a through 6c show the burning area as regression proceeds for various mass addition regions of the example. After about 38" of regression, the transition surfaces begin to disappear, and the logic for determining the sucession of intersections momentarily fails. This causes the anomalous spike in the burning area curve seen in figure 6b. The magnitude and extent of this spike is not large.

5. Further remarks

By using some of the new subroutines, the computation of the slot burning and aft region burning could be streamlined. In addition, none of the mass addition regions, save the star region, account for non constant burn rate. This can be added in a rather straightforward way.

Figure 6a
Fuel surface area, star region

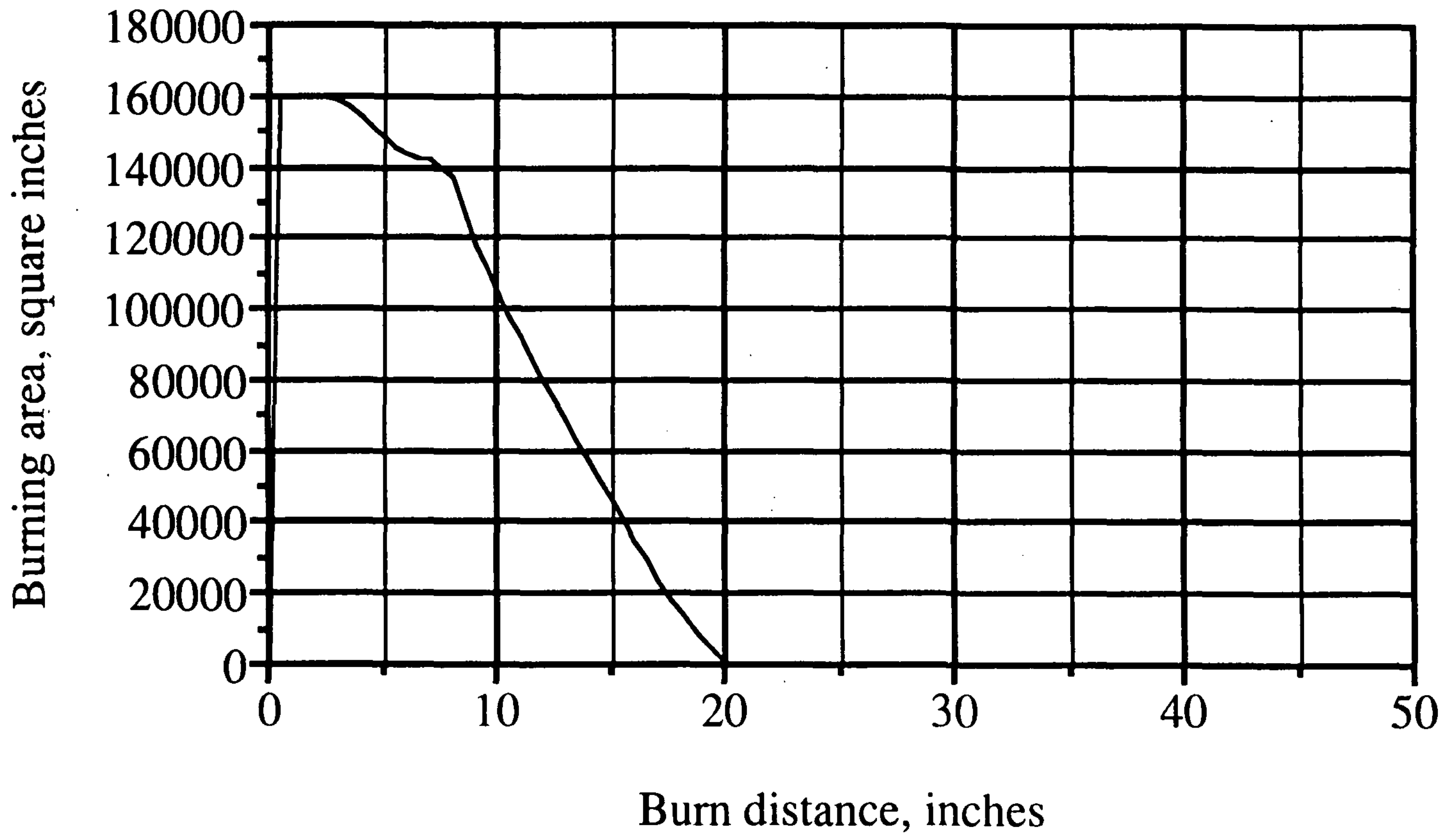


Figure 6b
Fuel surface area, transition region

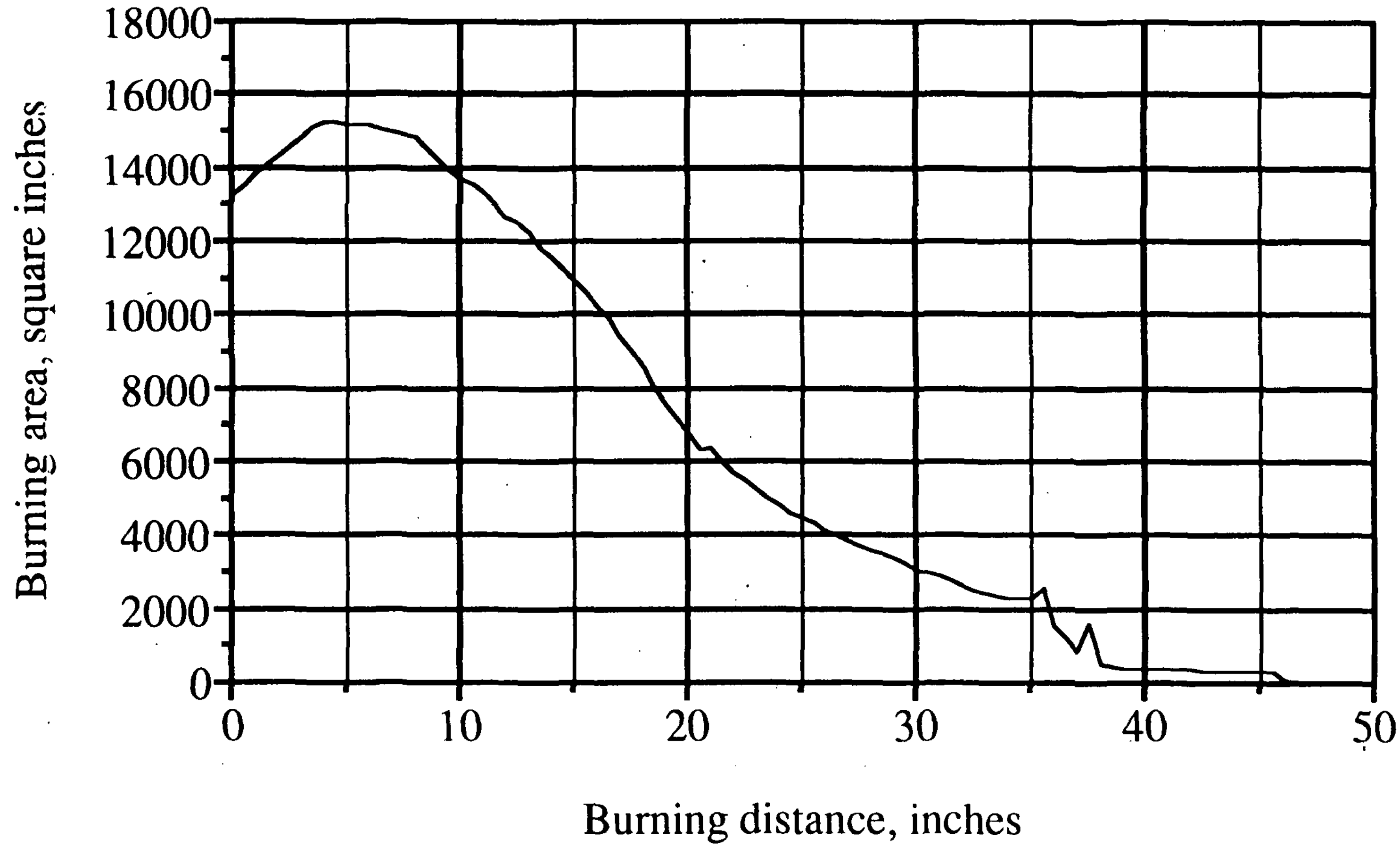
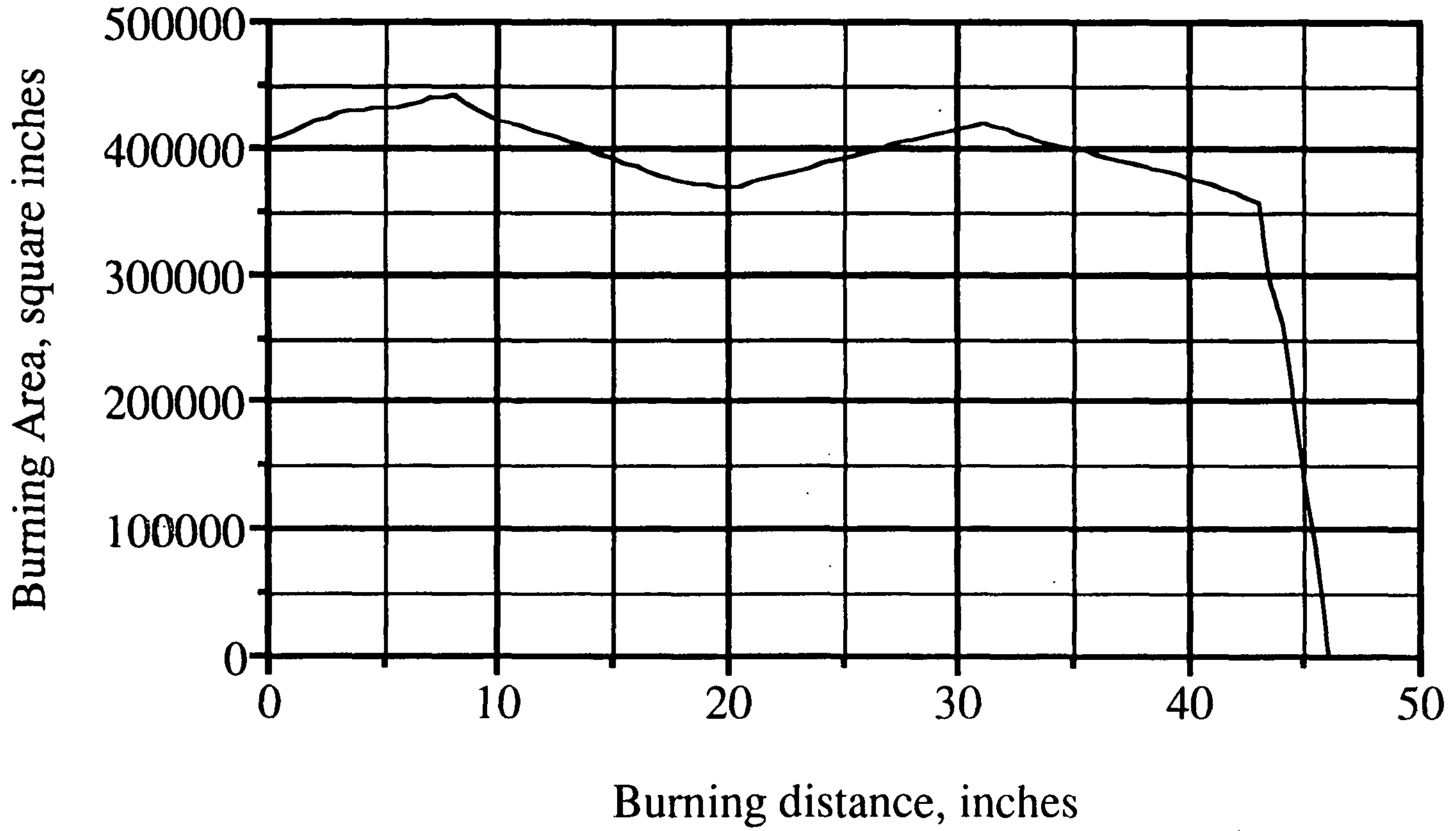


Figure 6c
Fuel surface area between both tangent planes



While a great deal of effort has been devoted to making CBRM-A flexible, it is by no means a general purpose program. It should be able to handle all simple variations on the ASRM propellant grain using the current concept as a baseline. If additional surfaces are incorporated into the design, some recoding will be necessary. Computer Aided Design (CAD) software such as the BRL-CAD provides an alternative way of accomplishing what the CBRM family of programs does by combinatorial geometric means and offers a greater flexibility for readily changing configurations.

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2. Winkler, J. C., and Kingsbury, J. A., *"Users (sic) Manual for the Solid Rocket Booster Internal Ballistics Module (SRIBM2)"*, Northrop Services, Inc., Huntsville, Alabama, TR-225-1787, April 77.

APPENDIX A

DESCRIPTION OF INPUT AND AN EXAMPLE WITH OUTPUT LISTING

1. Contents of the Appendix

This appendix begins with a general discussion of the input expected by the CBRM-A code. This is followed by a listing of the input corresponding to the most recent iteration on the configuration for the ASRM as of the publication of this report. This listing annotates the new input and changed input. A partial listing of the output is also included.

2. Input to code

Familiarity with the input to CBRM is assumed. The differences and additions caused by modifying the program to the CBRM-A version are stressed. All input is still achieved with the namelist IB2DAT.

a. Placement of reference planes

Figure A1 represents a longitudinal section of the star and transition sections of a hypothetical grain configuration which can be handled by CBRM-A. Reference planes may be inserted as needed to describe the star region geometry. The NRFth reference plane is set at the end of the star region. The arrays have been dimensioned to accommodate up to 10 reference planes in the star section (NRF<11). The reader is reminded that the initial configuration of the star region is constrained so that planes S2, S3 and S4 must be continuous throughout the star region. The following reference plane, number NRF+1, is placed at the beginning of the CP region - there are no intervening ones. CBRM-A thus does not require as many reference planes in the transition region as did CBRM. The ASRM concept requires only 4 reference planes throughout the star and transition regions; one at the forward tangent plane, one at the discontinuity in the slope of the case, one at the end of the star region, and the fourth plane is the one which introduces the pure CP region.

The quantities which are input through the reference plane array remain the same; its z-coordinate, port radius, radius of valley floor, and case radius.

b. Introduction of new star region variables

Figure A2 depicts cross sections of the star region at its beginning (reference plane 1), and at its end (reference plane NRF). The RSRM star valley was of constant width whereas the ASRM valley may taper with z. Consequently, the CBRM input quantity RTOPTP was replaced with the two quantities RTOPTF and RTOPTA, identified in the drawing. The x-coordinates of the valley wall discontinuities at both the forward and aft ends of the star region are given (XHIF, XLOF, XHIA, XLOA) are given, but the y-coordinates are only given at reference plane NRF. This avoids overspecifying the surfaces by assuring that only three points are given or determined in each of the three planes, S2, S3, and S4 which are assumed to be continuous throughout the star region before burning starts.

c. Introduction of new transition region variables

Figures A1 and A3 illustrate the quantities which must be provided to CBRM-A to define the transition region. In CBRM, the variable α_4 was an input. From drawings of the new geometry it is seen that the value of z at the end of the transition region, reference plane NRF+1, the radius of the climb-out arc, R3, and the reference plane data at NRF are adequate and α_4 is not explicitly input. The fillet radius in the climb-out corners is assumed to be the same as that in the corners of the star valleys (FR). The width of the flare at the aft end of the transition region, WIDCO in figure A3, completes the description of the transition region.

d. Range of geometric parameters yielding credible solutions

To check robustness of the code, the grain regression was modelled and graphically depicted to see if the propellant surface followed a reasonable course during burning while the geometric parameters were varied within reasonable limits. In many cases it was necessary to vary more than one input variable in order to keep the input consistent.

- Star Valley Floor Radius

The star valley floor radius (RVF) was increased by both two, six, and eight inches without difficulty; however, problems were encountered when RVF was decreased by over three inches from the nominal case, because the valley floor got so close to the case that point P (figure 4) was no longer on the star centerline.

- Star Wall Hip Location and Hip Angle

Four variables, XHIA, XLOF,XHIF, and XLOA were varied to move the hip up and down while holding the hip angle constant. The hip was moved up five inches and down eight inches without difficulty. Moving the hip up more than five inches causes cylinder one (CY1) to intersect cone one (CN1). This intersection is not taken into account in the computer code.

- Star Valley Floor Width

The width of the small plane forming the star valley floor was varied by changing the value of RBOTTP, which is the distance from the x-axis to the intersection of the star wall and the fillet in the star valley. To make the the star valley plane equal to zero, RBOTTP was set to the fillet radius (FR), 1.62". No difficulty was encountered for RBOTTP between 1.875" and 1.62".

- Port Radius

The port radius was changed by varying the values of the first three elements of the array RI. The port radius can be varied over the range of ten to twenty inches. Values greater than twenty inches do not work since this brings the star peak very close to star hip location.

- Change Climbout Angle

The climbout angle of the transition region (α_4) was varied by changing the fourth element in the array AINCIN along with ZTO (the center of the torus). Aincin(4) and ZTO must be changed by equal amounts, i.e. if you add ten inches to AINCIN(4) then you must add ten inches to ZTO. When α_4 was changed, some small errors appeared which should not affect the numerical results of running the program. α_4 four was varied from ten to 50 degrees with no difficulty.

- Dimensions of the Transition Flare

The width of the transition is twice the value of WIDCO. WIDCO was increased and decreased by up to two inches without difficulty.

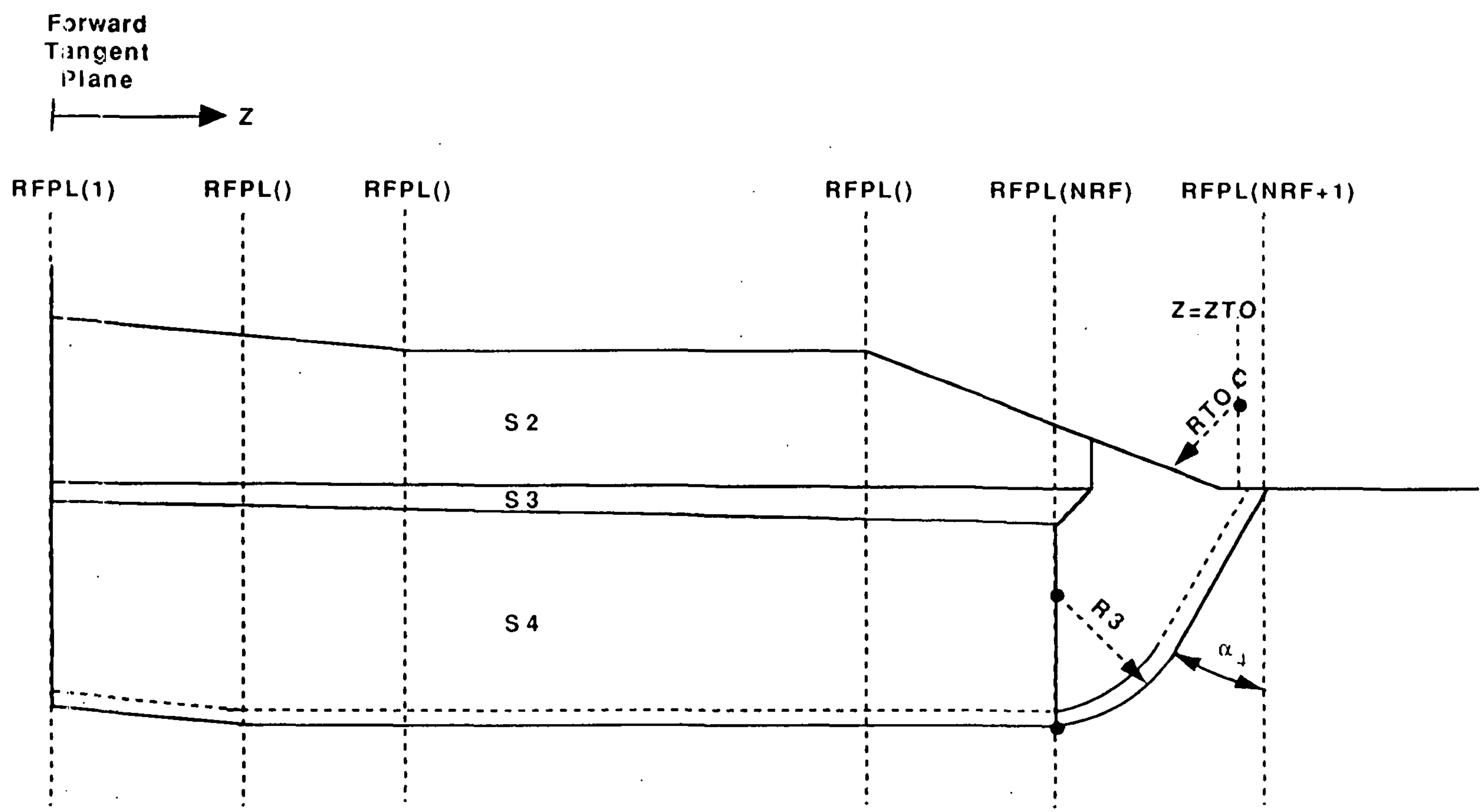
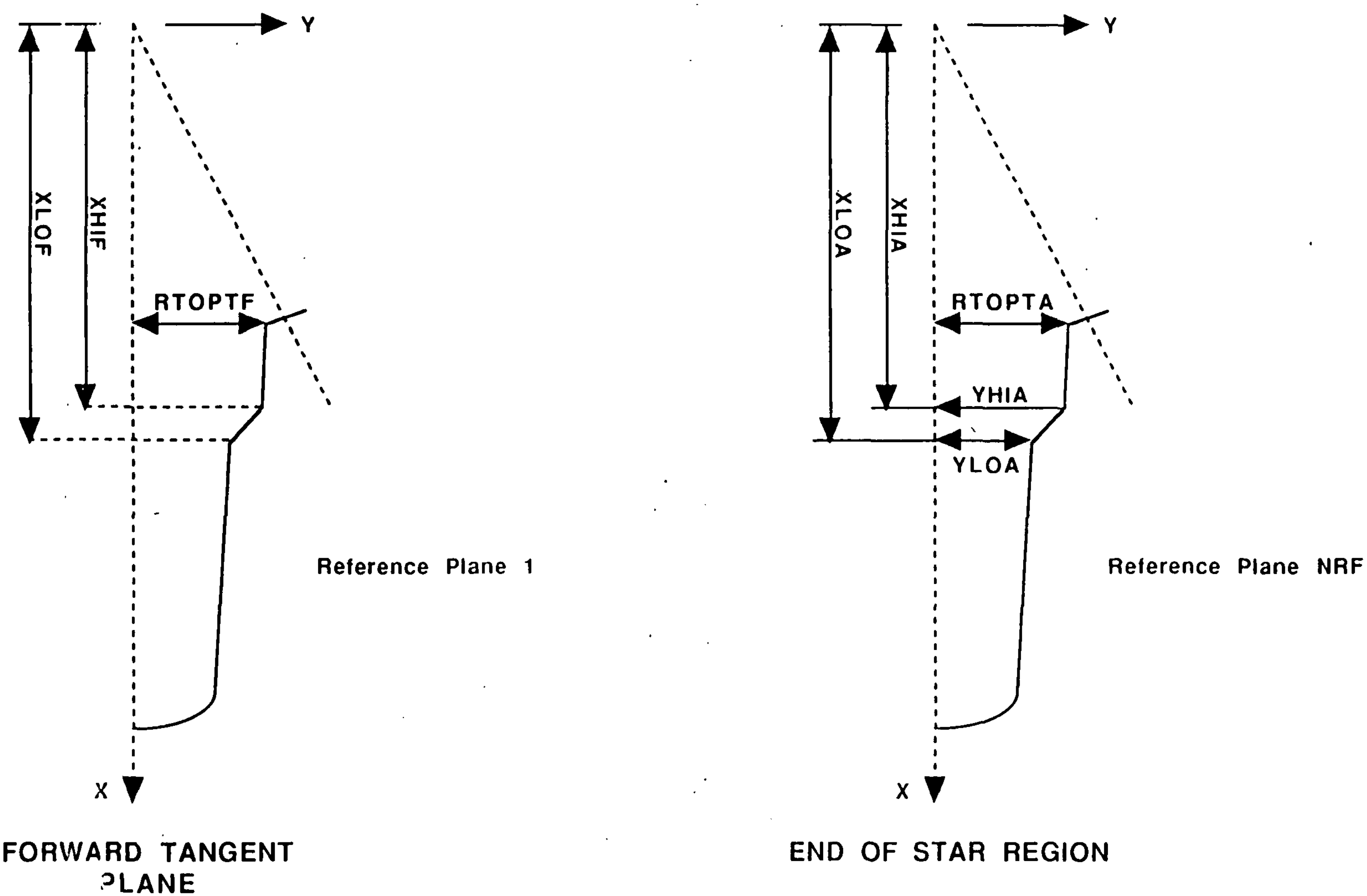


FIGURE A-1 LONGITUDINAL SECTION OF STAR AND TRANSITION REGIONS THROUGH THE VALLEY FLOOR

FIGURE A-2 STAR SECTION INPUT TO CBRM-A



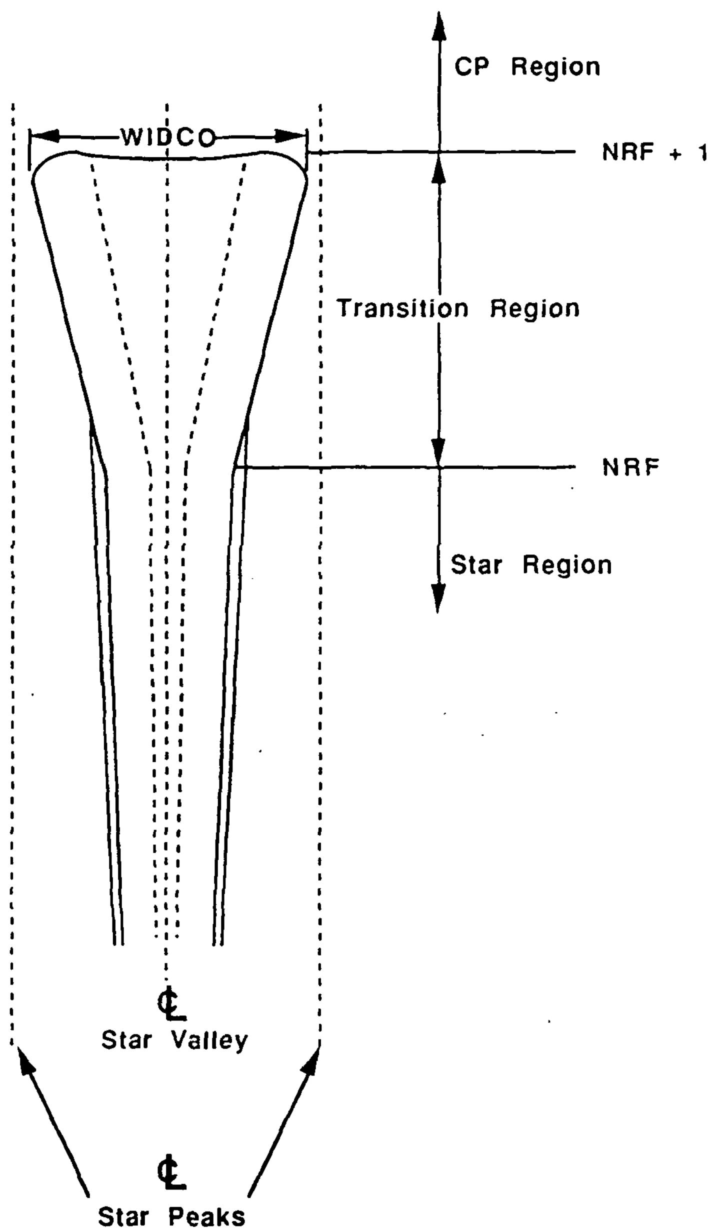


FIGURE A-3 VIEW FROM PORT OF TRANSITION REGION

LISTING OF PROGRAM INPUT - SAMPLE PROBLEM

```
 $IB2DAT
AINCIN= 0.0, 57.64, 142.28, 161.81, 250.0, 317.322,
318.17, 323.314, 324.162, 350.0, 400.0, 434.89,
481.122, 483.345, 522.615, 637.322, 638.172,
643.312, 644.162, 650.0, 725.0, 788.722, 797.322,
798.172, 803.312, 804.162, 833.22, 915.771, 961.282,
963.522, 1057.792, 1150.0, 1253.207, 1283.507, 1289.627,
15*0.0,
RI= 3*17.0, 28.0, 28.787, 29.359, 29.366, 29.41, 29.417,
29.636, 30.061, 30.36, 30.75, 2*28.4, 29.1565, 29.1621,
29.1961, 29.2017, 29.24, 29.7366, 30.1582, 30.2151, 30.2208,
30.2548, 30.2604, 30.452, 30.9989, 31.3, 2*30.7, 35.5613,
41.0025, 42.6, 45.627, 15*0.0,
RVF=64.3, 2*66.2, 62.51, 28.787, 29.359, 29.366, 29.4095,
29.417, 29.636, 30.061, 30.36, 55.0, 28.4, 28.4,
29.1565, 29.1621,
29.1961, 29.2017, 29.24, 29.7366, 30.1582, 30.2151, 30.2208,
30.2548, 30.2604, 30.4527, 30.9989, 55.0, 30.7, 30.7, 35.5613,
41.0025, 42.6, 45.627, 15*0.0,
RF=71.854, 2*73.7, 74.3, 2*74.375, 74.317, 74.317, 3*74.375,
74.375, 68.000, 70.5, 2*74.375, 2*74.317,
4*74.375, 74.371, 74.313,
74.308, 74.366, 74.35, 74.317, 68.000, 70.12, 74.12, 73.728,
73.295, 72.674, 72.1910, 15*0.0,
DELTXF= 20.992, 20.333, 0.0, 0.0, 0.0,
DELTYF= 5.16, 5.161, 0.0, 0.0, 0.0,
TIF= .3, .3, 0.0, 0.0, 0.0,
DELTXA= 6.555, 7.019, 0.0, 0.0, 0.0,
DELTYA= 3.875, 4.0, 0.0, 0.0, 0.0,
TIA= 0.0, 0.0, 0.0, 0.0, 0.0,
ZAFT= 1289.627, 1292.383, 1299.507,
1313.507, 1331.762, 15*0.0,
AFTRI=45.627, 47.2181, 51.3, 51.65, 52.7,
15*0.0,
CIRAD= 20*0.0,
ZCORD= 1289.627, 1290.393, 1291.978, 1292.383, 1297.656,
1305.806, 1309.792, 1312.291, 1315.468, 1318.749, 1320.749,
1325.589, 1329.436, 1330.464, 1331.581, 1331.687, 1331.762,
33*0.0,
XCORD= 72.191, 72.103, 71.783, 71.668, 70.244, 68.402,
67.374, 66.529, 65.14, 63.356, 62.16, 58.779, 56.176, 55.009,
53.779, 53.149, 52.7, 33*0.0,
NSTARS= 11,
NRF= 3,
KPLANE= 35,
RTOPTA= 3.0,
RTOPTF= 2.07337,
YHIA= 3.0,
YLOA= 1.875,
```

```
XHIA= 27.0,
XLOA= 29.0,
XHIF= 28.647,
XLOF= 29.0,
WIDCO= 6.0,
RBOTTP= 1.875,
R3= 4.0,
FR= 1.62,
DELZ= 20.0,
IISLOT= 13, 29, 3*0.0,
IDPNOZ= 2,
NOIDPS= 5,
NOCASE= 17,
NOCASA= 4,
TMAX= 100.0,
DTAU= 0.5,
NDUMP= 100,
NDUMPE= 0,
RANGLO= 0.0,
RANGHI= 0.0,
TSTART= 0.0,
RTO= 0.0,
ZTO= 157.31
$END
```

LISTING OF PROGRAM OUTPUT - SAMPLE PROBLEM

```
** BEGIN PROGRAM CBRM **
** BEGIN PROGRAM CBRM **

CBRM INPUT DATA FOLLOWS...
$ib2dat
aincin       =  0.0000000000000000E+00, 57.64000000000000,
                142.2800000000000, 161.8100000000000, 250.0000000000000,
                317.3220000000000, 318.1700000000000, 323.3140000000000,
                324.1620000000000, 350.0000000000000, 400.0000000000000,
                434.8900000000000, 481.1220000000000, 483.3450000000000,
                522.6150000000000, 637.3220000000000, 638.1720000000000,
                643.3120000000000, 644.1620000000000, 650.0000000000000,
                725.0000000000000, 788.7220000000000, 797.3220000000000,
                798.1720000000000, 803.3120000000000, 804.1620000000000,
                833.2200000000000, 915.7710000000000, 961.2820000000000,
                963.5220000000000, 1057.792000000000, 1150.000000000000,
                1253.207000000000, 1283.507000000000, 1289.627000000000,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00, 0.0000000000000000E+00,
                0.0000000000000000E+00
ri    =  17.00000000000000, 17.00000000000000, 17.00000000000000,
         28.00000000000000, 28.78700000000000, 29.35900000000000,
         29.36600000000000, 29.41000000000000, 29.41700000000000,
         29.63600000000000, 30.06100000000000, 30.36000000000000,
         30.75000000000000, 28.40000000000000, 28.40000000000000,
         29.15650000000000, 29.16210000000000, 29.19610000000000,
         29.20170000000000, 29.24000000000000, 29.73660000000000,
         30.15820000000000, 30.21510000000000, 30.22080000000000,
         30.25480000000000, 30.26040000000000, 30.45200000000000,
         30.99890000000000, 31.30000000000000, 30.70000000000000,
         30.70000000000000, 35.56130000000000, 41.00250000000000,
         42.60000000000000, 45.62700000000000, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
rvf   =  64.30000000000000, 66.20000000000000, 66.20000000000000,
         62.51000000000000, 28.78700000000000, 29.35900000000000,
         29.36600000000000, 29.40950000000000, 29.41700000000000,
         29.63600000000000, 30.06100000000000, 30.36000000000000,
```

```
         55.00000000000000, 28.40000000000000, 28.40000000000000,
         29.15650000000000, 29.16210000000000, 29.19610000000000,
         29.20170000000000, 29.24000000000000, 29.73660000000000,
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         42.00000000000000, 45.62700000000000, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
rf     = 71.65400000000000, 73.70000000000000, 73.70000000000000,
         74.30000000000000, 74.37500000000000, 74.37500000000000,
         74.31699999999999, 74.31699999999999, 74.37500000000000,
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         74.37500000000000, 74.37500000000000, 74.37500000000000,
         74.37500000000000, 74.37100000000000, 74.31300000000000,
         74.30800000000001, 74.36600000000000, 74.34999999999999,
         74.31699999999999, 68.00000000000000, 70.12000000000000,
         74.12000000000000, 73.72799999999999, 73.29500000000000,
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         0.0000000000000000E+00, 0.0000000000000000E+00
deltxf       = 20.99200000000000, 20.33300000000000, 0.0000000000000000E+00,
                 0.0000000000000000E+00, 0.0000000000000000E+00
deltyf       = 5.160000000000000, 5.161000000000000, 0.0000000000000000E+00,
                 0.0000000000000000E+00, 0.0000000000000000E+00
tif    = 0.3000000000000000, 0.3000000000000000, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
deltxa       = 6.555000000000000, 7.019000000000000, 0.0000000000000000E+00,
                 0.0000000000000000E+00, 0.0000000000000000E+00
deltya       = 3.875000000000000, 4.000000000000000, 0.0000000000000000E+00,
                 0.0000000000000000E+00, 0.0000000000000000E+00
tia    = 0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00
zaft   = 1289.627000000000, 1292.383000000000, 1299.507000000000,
```

```
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
aftri =  45.62700000000000, 47.21810000000000, 51.30000000000000,
         51.65000000000000, 52.70000000000000, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
cirad =  0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
zcord =  1289.627000000000, 1290.393000000000, 1291.978000000000,
         1292.383000000000, 1297.656000000000, 1305.806000000000,
         1309.792000000000, 1312.291000000000, 1315.468000000000,
         1318.749000000000, 1320.749000000000, 1325.589000000000,
         1329.436000000000, 1330.464000000000, 1331.581000000000,
         1331.687000000000, 1331.762000000000, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
xcord =  72.19100000000000, 72.10299999999999, 71.78300000000000,
         71.56800000000001, 70.24400000000000, 68.40200000000000,
         67.37400000000000, 66.52900000000000, 65.14000000000000,
         63.35600000000000, 62.16000000000000, 58.77900000000000,
         56.17600000000000, 55.00900000000000, 53.77900000000000,
         53.14900000000000, 52.70000000000000, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
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         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00,
         0.0000000000000000E+00, 0.0000000000000000E+00
nstars      =           11
nrf   =           3
kplane      =           35
rtopta      =  3.000000000000000
rtoptf      =  2.073370000000000
yhia  =  3.000000000000000
yloa  =  1.875000000000000
xhia  =  27.00000000000000
xloa  =  29.00000000000000
xhif  =  28.64700000000000
xlof  =  29.00000000000000
widco =  6.000000000000000
rbottp      =  1.875000000000000
r3    =  4.000000000000000
fr    =  1.620000000000000
delz  =  20.00000000000000
iislot      =           13,          29,           0,           0,           0
idpnoz      =            2
noidps      =            5
nocase      =           17
nocasa      =            4
```

```
tmax   =  100.0000000000000
dtau   =  0.5000000000000000
ndump  =          100
ndumpe        =              0
ranglo        =  0.0000000000000000E+00
ranghi        =  0.0000000000000000E+00
tstart        =  0.0000000000000000E+00
rto    =  0.0000000000000000E+00
zto    =  157.3100000000000
$end
END OF INPUT DATA


AFTVOL=  571475.71       AFTVOA=  44785.691       AFTVOB=  526690.02
```

0.00000000E+00	17.000000	62.680000	71.807000	0.00000000E+00
20.000000	17.000000	63.339264	72.447527	0.00000000E+00
40.000000	17.000000	63.998529	73.088055	0.00000000E+00
57.640000	17.000000	64.580000	73.653000	0.00000000E+00
77.640000	17.000000	64.580000	73.653000	0.00000000E+00
97.640000	17.000000	64.580000	73.653000	0.00000000E+00
117.64000	17.000000	64.580000	73.653000	0.00000000E+00
122.28000	17.000000	64.580000	73.653000	0.00000000E+00
142.28000	17.000000	64.580000	73.653000	0.00000000E+00
161.81000	28.000000	62.510000	74.253000	0.00000000E+00
181.81000	28.178478	28.178478	74.270009	0.00000000E+00
201.81000	28.356957	28.356957	74.287017	0.00000000E+00
221.81000	28.535435	28.535435	74.304026	0.00000000E+00
241.81000	28.713913	28.713913	74.321035	0.00000000E+00
250.00000	28.787000	28.787000	74.328000	0.00000000E+00
270.00000	28.956930	28.956930	74.328000	0.00000000E+00
290.00000	29.126859	29.126859	74.328000	0.00000000E+00
310.00000	29.296789	29.296789	74.328000	0.00000000E+00
317.32200	29.359000	29.359000	74.328000	0.00000000E+00
318.17000	29.366000	29.366000	74.270000	0.00000000E+00
323.31400	29.410000	29.410000	74.270000	0.00000000E+00
324.16200	29.417000	29.417000	74.328000	0.00000000E+00
344.16200	29.586518	29.586518	74.328000	0.00000000E+00

350.00000	29.636000	29.636000	74.328000	0.00000000E+00
370.00000	29.806000	29.806000	74.328000	0.00000000E+00
390.00000	29.976000	29.976000	74.328000	0.00000000E+00
400.00000	30.061000	30.061000	74.328000	0.00000000E+00
420.00000	30.232396	30.232396	74.328000	0.00000000E+00
434.89000	30.360000	30.360000	74.328000	0.00000000E+00
441.94286	30.419496	30.419496	73.984406	0.00000000E+00***
481.12200	30.750000	55.000000	67.953000	0.00000000E+00
483.34500	28.400000	28.400000	70.453000	0.00000000E+00
489.90000	28.400000	28.400000	74.328000	0.00000000E+00
509.90000	28.400000	28.400000	74.328000	0.00000000E+00
522.61500	28.400000	28.400000	74.328000	0.00000000E+00
542.61500	28.531901	28.531901	74.328000	0.00000000E+00
562.61500	28.663803	28.663803	74.328000	0.00000000E+00
582.61500	28.795704	28.795704	74.328000	0.00000000E+00
602.61500	28.927605	28.927605	74.328000	0.00000000E+00
622.61500	29.059506	29.059506	74.328000	0.00000000E+00
637.32200	29.156500	29.156500	74.328000	0.00000000E+00
638.17200	29.162100	29.162100	74.270000	0.00000000E+00
643.31200	29.196100	29.196100	74.270000	0.00000000E+00
644.16200	29.201700	29.201700	74.328000	0.00000000E+00
650.00000	29.240000	29.240000	74.328000	0.00000000E+00
670.00000	29.372427	29.372427	74.328000	0.00000000E+00

690.00000	29.504853	29.504853	74.328000	0.00000000E+00
710.00000	29.637280	29.637280	74.328000	0.00000000E+00
725.00000	29.736600	29.736600	74.328000	0.00000000E+00
745.00000	29.868925	29.868925	74.328000	0.00000000E+00
765.00000	30.001250	30.001250	74.328000	0.00000000E+00
785.00000	30.133574	30.133574	74.328000	0.00000000E+00
788.72200	30.158200	30.158200	74.328000	0.00000000E+00
797.32200	30.215100	30.215100	74.324000	0.00000000E+00
798.17200	30.220800	30.220800	74.266000	0.00000000E+00
803.31200	30.254800	30.254800	74.261000	0.00000000E+00
804.16200	30.260400	30.260400	74.319000	0.00000000E+00
824.16200	30.392274	30.392274	74.307988	0.00000000E+00
833.22000	30.452000	30.452000	74.303000	0.00000000E+00
853.22000	30.584500	30.584500	74.295005	0.00000000E+00
873.22000	30.717000	30.717000	74.287010	0.00000000E+00
893.22000	30.849500	30.849500	74.279015	0.00000000E+00
915.77100	30.998900	30.998900	74.270000	0.00000000E+00
922.82639	31.045578	31.045578	73.942159	0.00000000E+00***
961.28200	31.300000	55.000000	67.953000	0.00000000E+00
963.52200	30.700000	30.700000	70.073000	0.00000000E+00
970.54100	30.700000	30.700000	74.073000	0.00000000E+00
990.54100	30.700000	30.700000	74.073000	0.00000000E+00
1010.5410	30.700000	30.700000	74.073000	0.00000000E+00

```
1030.5410          30.700000          30.700000          74.073000          0.00000000E+00
1050.5410          30.700000          30.700000          74.073000          0.00000000E+00
1057.7920          30.700000          30.700000          74.073000          0.00000000E+00
1077.7920          31.754420          31.754420          73.987975          0.00000000E+00
1097.7920          32.808841          32.808841          73.902950          0.00000000E+00
1117.7920          33.863261          33.863261          73.817925          0.00000000E+00
1137.7920          34.917682          34.917682          73.732899          0.00000000E+00
1150.0000          35.561300          35.561300          73.681000          0.00000000E+00
1170.0000          36.615725          36.615725          73.597091          0.00000000E+00
1190.0000          37.670149          37.670149          73.513182          0.00000000E+00
1210.0000          38.724574          38.724574          73.429273          0.00000000E+00
1230.0000          39.778998          39.778998          73.345364          0.00000000E+00
1250.0000          40.833423          40.833423          73.261455          0.00000000E+00
1253.2070          41.002500          41.002500          73.248000          0.00000000E+00
1273.2070          42.056955          42.056955          72.838099          0.00000000E+00
1283.5070          42.600000          42.600000          72.627000          0.00000000E+00
1289.6270          45.627000          45.627000          72.144000          0.00000000E+00
  31        65        0         0         0         0         0         0         0         0
  32        66        0         0         0        13        29         0         0         0
      2.08966            -0.10174            1.98792
MAR=  0 CASVOL= 0.00000000D+00 VOLINH= 0.00000000D+00
MAR=  1 CASVOL= 0.32687494D+06 VOLINH= 0.00000000D+00
MAR=  2 CASVOL= 0.65958126D+06 VOLINH= 0.00000000D+00
MAR=  3 CASVOL= 0.95790916D+06 VOLINH= 0.00000000D+00
MAR=  4 CASVOL= 0.12987572D+07 VOLINH= 0.00000000D+00
MAR=  5 CASVOL= 0.16396052D+07 VOLINH= 0.00000000D+00
```

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MAR=  6 CASVOL= 0.19804531D+07 VOLINH= 0.00000000D+00
MAR=  7 CASVOL= 0.20595299D+07 VOLINH= 0.00000000D+00
MAR=  8 CASVOL= 0.24003779D+07 VOLINH= 0.00000000D+00
MAR=  9 CASVOL= 0.27359347D+07 VOLINH= 0.00000000D+00
MAR= 10 CASVOL= 0.30824380D+07 VOLINH= 0.00000000D+00
MAR= 11 CASVOL= 0.34291000D+07 VOLINH= 0.00000000D+00
MAR= 12 CASVOL= 0.37759208D+07 VOLINH= 0.00000000D+00
MAR= 13 CASVOL= 0.41229004D+07 VOLINH= 0.00000000D+00
MAR= 14 CASVOL= 0.42650344D+07 VOLINH= 0.00000000D+00
MAR= 15 CASVOL= 0.46121585D+07 VOLINH= 0.00000000D+00
MAR= 16 CASVOL= 0.49592826D+07 VOLINH= 0.00000000D+00
MAR= 17 CASVOL= 0.53064067D+07 VOLINH= 0.00000000D+00
MAR= 18 CASVOL= 0.54334888D+07 VOLINH= 0.00000000D+00
MAR= 19 CASVOL= 0.54481954D+07 VOLINH= 0.00000000D+00
MAR= 20 CASVOL= 0.55373364D+07 VOLINH= 0.00000000D+00
MAR= 21 CASVOL= 0.55520430D+07 VOLINH= 0.00000000D+00
MAR= 22 CASVOL= 0.58991671D+07 VOLINH= 0.00000000D+00
MAR= 23 CASVOL= 0.60004926D+07 VOLINH= 0.00000000D+00
MAR= 24 CASVOL= 0.63476167D+07 VOLINH= 0.00000000D+00
MAR= 25 CASVOL= 0.66947408D+07 VOLINH= 0.00000000D+00
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MAR= 27 CASVOL= 0.72154269D+07 VOLINH= 0.00000000D+00
MAR= 28 CASVOL= 0.74738608D+07 VOLINH= 0.00000000D+00
MAR= 29 CASVOL= 0.75957068D+07 VOLINH= 0.00000000D+00
MAR= 32 CASVOL= 0.83736632D+07 VOLINH= 0.15009997D+04
MAR= 33 CASVOL= 0.87207873D+07 VOLINH= 0.15009997D+04
MAR= 34 CASVOL= 0.89414714D+07 VOLINH= 0.15009997D+04
MAR= 35 CASVOL= 0.92885955D+07 VOLINH= 0.15009997D+04
MAR= 36 CASVOL= 0.96357196D+07 VOLINH= 0.15009997D+04
MAR= 37 CASVOL= 0.99828437D+07 VOLINH= 0.15009997D+04
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MAR= 39 CASVOL= 0.10677092D+08 VOLINH= 0.15009997D+04
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MAR= 43 CASVOL= 0.11050904D+08 VOLINH= 0.15009997D+04
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MAR= 48 CASVOL= 0.12453945D+08 VOLINH= 0.15009997D+04
MAR= 49 CASVOL= 0.12801069D+08 VOLINH= 0.15009997D+04
MAR= 50 CASVOL= 0.13148193D+08 VOLINH= 0.15009997D+04
MAR= 51 CASVOL= 0.13495317D+08 VOLINH= 0.15009997D+04
MAR= 52 CASVOL= 0.13559917D+08 VOLINH= 0.15009997D+04
MAR= 53 CASVOL= 0.13709172D+08 VOLINH= 0.15009997D+04
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MAR= 55 CASVOL= 0.13812968D+08 VOLINH= 0.15009997D+04
MAR= 56 CASVOL= 0.13827706D+08 VOLINH= 0.15009997D+04
MAR= 57 CASVOL= 0.14174694D+08 VOLINH= 0.15009997D+04
MAR= 58 CASVOL= 0.14331811D+08 VOLINH= 0.15009997D+04
MAR= 59 CASVOL= 0.14678665D+08 VOLINH= 0.15009997D+04
MAR= 60 CASVOL= 0.15025443D+08 VOLINH= 0.15009997D+04
MAR= 61 CASVOL= 0.15372147D+08 VOLINH= 0.15009997D+04
MAR= 62 CASVOL= 0.15762984D+08 VOLINH= 0.15009997D+04
MAR= 63 CASVOL= 0.15884709D+08 VOLINH= 0.15009997D+04
MAR= 66 CASVOL= 0.16657800D+08 VOLINH= 0.30019995D+04
MAR= 67 CASVOL= 0.17002546D+08 VOLINH= 0.30019995D+04
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MAR= 69 CASVOL= 0.17692039D+08 VOLINH= 0.30019995D+04
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MAR= 71 CASVOL= 0.18161773D+08 VOLINH= 0.30019995D+04
MAR= 72 CASVOL= 0.18506124D+08 VOLINH= 0.30019995D+04
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MAR= 75 CASVOL= 0.19534437D+08 VOLINH= 0.30019995D+04
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MAR= 78 CASVOL= 0.20423457D+08 VOLINH= 0.30019995D+04
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MAR= 81 CASVOL= 0.21438639D+08 VOLINH= 0.30019995D+04
MAR= 82 CASVOL= 0.21492704D+08 VOLINH= 0.30019995D+04
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
          PSIBAR=     6.2831852    PORT PERIMETER=    178.44246    PORT AREA=    2533.8829
CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
          PSIBAR=     6.2831852     PORT PERIMETER=     192.89379     PORT AREA=     2960.9196
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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              2              2              4              2              5              17 0.00000000D+00

   0.12923830D+04     0.12896270D+04
 0.71621000D+02 0.69778651D+02-0.22601227D+00 0.36348318D+03 0.12995070D+04 0.51300000D+02 0.00000000D+00 0.00000000D+00
              3              4              6              2              5              17 0.00000000D+00

   0.12995070D+04     0.12923830D+04
 0.69778651D+02 0.65950359D+02-0.43720491D+00 0.64022207D+03 0.13135070D+04 0.51650000D+02 0.00000000D+00 0.00000000D+00
              4              6              9              2              5              17 0.00000000D+00

   0.13135070D+04     0.12995070D+04
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              5              9              17              2              5              17 0.00000000D+00

  0.13317620D+04   0.13135070D+04
 1   1289.6270       45.627000       1.0000000       0.00000000E+00   0.00000000E+00   0.00000000E+00

 2   1292.3830       47.218100       1.0000000       0.00000000E+00   0.57732221       0.00000000E+00

 3   1299.5070       51.300000       1.0000000       0.00000000E+00   0.57297866       0.00000000E+00

 4   1313.5070       51.650000       1.0000000       0.00000000E+00   0.25000000E-01   0.00000000E+00

 5   1331.7620       52.700000       1.0000000       0.00000000E+00   0.57518488E-01   0.00000000E+00

BURNOUT POINT CALCULATED AT1331.7620     WITH PORT RADIUS AT 52.700000
THE VALUE WAS USED ONLY IF THE POSITION DID NOT COINCIDE WITH AN IDP.
      IDPNUM                   AREAFT                VOLAFT
        2                 928.22264                  18660.771
        3                 2541.1988                  54336.828
        4                 4529.3922                  116539.27
        5                 5994.3400                  156124.58
AREAA=928.22264      AREAB=13064.931       VOLA=18660.771       VOLB=327000.67

*************************************************************************************************************************

*******************************BURNOUT BETWEEN PLANES    3  AND    2  *******************************
                                   ARTIFICIAL PLANE SET AT       19.619784


*************************************************************************************************************************
CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17337.070
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CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17352.952
CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17356.205
CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17356.205
CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17356.205
CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17356.205
CPBURN VALUES-----
                  PSIBAR=       6.2831852    PORT PERIMETER=     0.00000000E+00 PORT AREA=      17356.205
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CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
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        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17196.111
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CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17329.128
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17329.128
CPBURN VALUES-----
        PSIBAR=    6.2831852    PORT PERIMETER=    0.00000000E+00 PORT AREA=    17356.205
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CPBURN VALUES-----
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CPBURN VALUES-----
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          PSIBAR=    6.2831852   PORT PERIMETER=   0.00000000E+00 PORT AREA=    17237.320
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          PSIBAR=    6.2831852   PORT PERIMETER=   0.00000000E+00 PORT AREA=    17237.320
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
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CPBURN VALUES-----
          PSIBAR=     6.2831852     PORT PERIMETER=     0.00000000E+00 PORT AREA=     16667.370
CPBURN VALUES-----
          PSIBAR=     6.2831852     PORT PERIMETER=     0.00000000E+00 PORT AREA=     16570.899
CPBURN VALUES-----
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PARAMETER SUMMARY-GRAIN DESIGN (THIOKOL)TC227CDR

FUEL SURFACE AREA---BETWEEN BOTH TANGENT PLANES---SQUARE INCHES

.00000000E+00	411133.77	17.000000	376553.68	34.000000	404152.70
.50000000	414422.63	17.500000	373814.56	34.500000	402185.44
1.0000000	418088.47	18.000000	371738.13	35.000000	400152.21
1.5000000	421798.01	18.500000	370148.37	35.500000	398287.55
2.0000000	425517.07	19.000000	368720.13	36.000000	396481.39
2.5000000	429210.17	19.500000	367737.40	36.500000	394130.45
3.0000000	432370.67	20.000000	368781.98	37.000000	391423.40
3.5000000	434358.53	20.500000	371451.60	37.500000	389105.31
4.0000000	435282.35	21.000000	373712.06	38.000000	386480.44
4.5000000	435770.70	21.500000	376060.73	38.500000	385124.64
5.0000000	436261.64	22.000000	378410.55	39.000000	381974.67
5.5000000	437059.14	22.500000	380814.82	39.500000	379635.82
6.0000000	438587.32	23.000000	383236.10	40.000000	376967.44
6.5000000	440890.34	23.500000	385665.32	40.500000	374256.07
7.0000000	444001.26	24.000000	388094.33	41.000000	371501.61
7.5000000	441777.18	24.500000	390503.76	41.500000	368718.68
8.0000000	433849.77	25.000000	393038.96	42.000000	365878.67
8.5000000	429555.67	25.500000	395496.62	42.500000	362658.48
9.0000000	425976.29	26.000000	397983.36	43.000000	358485.55
9.5000000	422850.78	26.500000	400475.25	43.500000	297919.36
10.000000	419960.13	27.000000	402896.82	44.000000	261233.57
10.500000	417169.47	27.500000	405376.25	44.500000	200567.06
11.000000	414380.89	28.000000	407772.50	45.000000	138399.88
11.500000	411711.01	28.500000	410138.58	45.500000	75692.232
12.000000	409186.05	29.000000	412486.46	46.000000	2863.5014
12.500000	406615.92	29.500000	414831.70	46.500000	.00000000E+00
13.000000	403993.04	30.000000	416840.46	47.000000	.00000000E+00
13.500000	400711.75	30.500000	418761.39	47.500000	.00000000E+00
14.000000	396986.58	31.000000	420701.48	48.000000	.00000000E+00
14.500000	393431.31	31.500000	418245.34	48.500000	.00000000E+00
15.000000	389993.29	32.000000	415456.38	49.000000	.00000000E+00
15.500000	386645.02	32.500000	412435.15	49.500000	.00000000E+00
16.000000	383181.49	33.000000	409249.47	50.000000	.00000000E+00
16.500000	379902.60	33.500000	406063.52	.00000000E+00	.00000000E+00

AFT END BURN AREA---A REGION---SQUARE INCHES

.00000000E+00	928.22264	17.000000	2628.6998	34.000000	.00000000E+00
.50000000	957.90854	17.500000	2696.8655	34.500000	.00000000E+00
1.0000000	989.10292	18.000000	2765.9518	35.000000	.00000000E+00
1.5000000	1021.7734	18.500000	2835.9539	35.500000	.00000000E+00
2.0000000	1055.8874	19.000000	2906.8675	36.000000	.00000000E+00
2.5000000	1091.4123	19.500000	2978.6885	36.500000	.00000000E+00
3.0000000	1128.3161	20.000000	3051.4128	37.000000	.00000000E+00
3.5000000	1166.5675	20.500000	3125.0369	37.500000	.00000000E+00
4.0000000	1206.1366	21.000000	3199.5572	38.000000	.00000000E+00
4.5000000	1246.9944	21.500000	4333.2754	38.500000	.00000000E+00
5.0000000	1289.1132	22.000000	4077.5306	39.000000	.00000000E+00
5.5000000	1332.4670	22.500000	3827.1547	39.500000	.00000000E+00
6.0000000	1377.0309	23.000000	3581.5866	40.000000	.00000000E+00
6.5000000	1422.7815	23.500000	3333.7506	40.500000	.00000000E+00
7.0000000	1469.6969	24.000000	3083.6468	41.000000	.00000000E+00
7.5000000	1517.7563	24.500000	2831.2753	41.500000	.00000000E+00
8.0000000	1566.9406	25.000000	2576.6359	42.000000	.00000000E+00
8.5000000	1617.2314	25.500000	2319.7286	42.500000	.00000000E+00
9.0000000	1668.6120	26.000000	2060.5536	43.000000	.00000000E+00
9.5000000	1721.0664	26.500000	1799.1107	43.500000	.00000000E+00
10.000000	1774.5800	27.000000	1535.4000	44.000000	.00000000E+00
10.500000	1829.1390	27.500000	1271.8657	44.500000	.00000000E+00
11.000000	1884.7304	28.000000	986.01372	45.000000	.00000000E+00
11.500000	1941.3424	28.500000	691.31678	45.500000	.00000000E+00
12.000000	1998.9637	29.000000	393.63757	46.000000	.00000000E+00
12.500000	2057.5838	29.500000	56.383926	46.500000	.00000000E+00
13.000000	2117.1931	30.000000	.00000000E+00	47.000000	.00000000E+00
13.500000	2177.7824	30.500000	.00000000E+00	47.500000	.00000000E+00
14.000000	2239.3432	31.000000	.00000000E+00	48.000000	.00000000E+00
14.500000	2301.8676	31.500000	.00000000E+00	48.500000	.00000000E+00
15.000000	2365.3482	32.000000	.00000000E+00	49.000000	.00000000E+00
15.500000	2429.7780	32.500000	.00000000E+00	49.500000	.00000000E+00
16.000000	2495.1505	33.000000	.00000000E+00	50.000000	.00000000E+00
16.500000	2561.4597	33.500000	.00000000E+00	.00000000E+00	.00000000E+00

TOTAL BURN AREA---CYLINDRICAL+AFT SECTIONS---SQUARE INCHES

.00000000E+00	425126.93	17.000000	384904.49	34.000000	404152.70
.50000000	428539.46	17.500000	381404.48	34.500000	402185.44
1.0000000	432332.16	18.000000	378555.97	35.000000	400152.21
1.5000000	436060.06	18.500000	376182.93	35.500000	398287.55
2.0000000	439786.47	19.000000	373976.67	36.000000	396481.39
2.5000000	443486.89	19.500000	372320.54	36.500000	394130.45
3.0000000	446656.13	20.000000	372682.21	37.000000	391423.40
3.5000000	448651.28	20.500000	375050.76	37.500000	389105.31
4.0000000	449498.21	21.000000	377034.41	38.000000	386480.44
4.5000000	449896.07	21.500000	380394.01	38.500000	385124.64
5.0000000	450293.44	22.000000	382488.08	39.000000	381974.67
5.5000000	450994.28	22.500000	384641.97	39.500000	379635.82
6.0000000	452422.66	23.000000	386817.69	40.000000	376967.44
6.5000000	454624.53	23.500000	388999.07	40.500000	374256.07
7.0000000	457636.72	24.000000	391177.98	41.000000	371501.61
7.5000000	455310.82	24.500000	393335.04	41.500000	368718.68
8.0000000	447278.49	25.000000	395615.59	42.000000	365878.67
8.5000000	442876.36	25.500000	397816.35	42.500000	362658.48
9.0000000	439185.80	26.000000	400043.91	43.000000	358485.55
9.5000000	435945.97	26.500000	402274.36	43.500000	297919.36
10.000000	432937.83	27.000000	404432.22	44.000000	261233.57
10.500000	429988.89	27.500000	406648.11	44.500000	200567.06
11.000000	427035.88	28.000000	408758.52	45.000000	138399.88
11.500000	424188.90	28.500000	410829.90	45.500000	75692.232
12.000000	421464.11	29.000000	412880.09	46.000000	2863.5014
12.500000	418689.95	29.500000	414888.09	46.500000	.00000000E+00
13.000000	415858.81	30.000000	416840.46	47.000000	.00000000E+00
13.500000	412336.77	30.500000	418761.39	47.500000	.00000000E+00
14.000000	408320.51	31.000000	420701.48	48.000000	.00000000E+00
14.500000	404468.89	31.500000	418245.34	48.500000	.00000000E+00
15.000000	400669.57	32.000000	415456.38	49.000000	.00000000E+00
15.500000	396860.38	32.500000	412435.15	49.500000	.00000000E+00
16.000000	392850.36	33.000000	409249.47	50.000000	.00000000E+00
16.500000	388927.80	33.500000	406063.52	.00000000E+00	.00000000E+00

FUEL SURFACE AREA---STAR REGION---SQUARE INCHES

.00000000E+00	164871.55	17.000000	21210.265	34.000000	.00000000E+00
.50000000	164642.13	17.500000	16192.811	34.500000	.00000000E+00
1.0000000	164453.04	18.000000	11914.551	35.000000	.00000000E+00
1.5000000	164287.77	18.500000	8057.6400	35.500000	.00000000E+00
2.0000000	164144.30	19.000000	4473.3705	36.000000	.00000000E+00
2.5000000	164020.25	19.500000	1200.1276	36.500000	.00000000E+00
3.0000000	163317.66	20.000000	.00000000E+00	37.000000	.00000000E+00
3.5000000	161492.55	20.500000	.00000000E+00	37.500000	.00000000E+00
4.0000000	158650.22	21.000000	.00000000E+00	38.000000	.00000000E+00
4.5000000	155613.65	21.500000	.00000000E+00	38.500000	.00000000E+00
5.0000000	152586.72	22.000000	.00000000E+00	39.000000	.00000000E+00
5.5000000	149833.87	22.500000	.00000000E+00	39.500000	.00000000E+00
6.0000000	147824.43	23.000000	.00000000E+00	40.000000	.00000000E+00
6.5000000	146715.10	23.500000	.00000000E+00	40.500000	.00000000E+00
7.0000000	146317.91	24.000000	.00000000E+00	41.000000	.00000000E+00
7.5000000	140639.46	24.500000	.00000000E+00	41.500000	.00000000E+00
8.0000000	129570.97	25.000000	.00000000E+00	42.000000	.00000000E+00
8.5000000	121988.23	25.500000	.00000000E+00	42.500000	.00000000E+00
9.0000000	115153.34	26.000000	.00000000E+00	43.000000	.00000000E+00
9.5000000	108680.55	26.500000	.00000000E+00	43.500000	.00000000E+00
10.000000	102422.76	27.000000	.00000000E+00	44.000000	.00000000E+00
10.500000	96306.930	27.500000	.00000000E+00	44.500000	.00000000E+00
11.000000	90291.269	28.000000	.00000000E+00	45.000000	.00000000E+00
11.500000	84349.667	28.500000	.00000000E+00	45.500000	.00000000E+00
12.000000	78464.751	29.000000	.00000000E+00	46.000000	.00000000E+00
12.500000	72624.423	29.500000	.00000000E+00	46.500000	.00000000E+00
13.000000	66819.952	30.000000	.00000000E+00	47.000000	.00000000E+00
13.500000	61044.859	30.500000	.00000000E+00	47.500000	.00000000E+00
14.000000	55294.220	31.000000	.00000000E+00	48.000000	.00000000E+00
14.500000	49564.225	31.500000	.00000000E+00	48.500000	.00000000E+00
15.000000	43851.872	32.000000	.00000000E+00	49.000000	.00000000E+00
15.500000	38154.769	32.500000	.00000000E+00	49.500000	.00000000E+00
16.000000	32470.981	33.000000	.00000000E+00	50.000000	.00000000E+00
16.500000	26798.930	33.500000	.00000000E+00	.00000000E+00	.00000000E+00

FUEL SURFACE AREA---TRANSITION REGION---SQUARE INCHES

.00000000E+00	12937.703	17.000000	9262.0580	34.000000	2276.6478
.50000000	13163.476	17.500000	8850.3271	34.500000	2182.4489
1.0000000	13406.391	18.000000	8358.5537	35.000000	2058.2369
1.5000000	13674.231	18.500000	7931.3417	35.500000	2138.6954
2.0000000	13934.841	19.000000	7394.3447	36.000000	2313.8902
2.5000000	14155.110	19.500000	6994.7858	36.500000	1980.6339
3.0000000	14426.372	20.000000	6553.6419	37.000000	1327.7226
3.5000000	14652.548	20.500000	6542.6616	37.500000	1100.3059
4.0000000	14836.949	21.000000	6128.6032	38.000000	602.74526
4.5000000	14785.153	21.500000	5809.5061	38.500000	1408.3697
5.0000000	14731.352	22.000000	5498.8673	39.000000	455.23363
5.5000000	14715.072	22.500000	5250.4690	39.500000	448.38964
6.0000000	14691.091	23.000000	5027.2656	40.000000	441.09152
6.5000000	14546.887	23.500000	4820.5225	40.500000	433.30015
7.0000000	14503.465	24.000000	4646.8874	41.000000	424.97277
7.5000000	14411.337	24.500000	4475.7920	41.500000	430.76880
8.0000000	14010.963	25.000000	4347.4844	42.000000	422.14800
8.5000000	13763.178	25.500000	4184.0141	42.500000	412.88577
9.0000000	13487.291	26.000000	4057.4249	43.000000	356.27798
9.5000000	13308.214	26.500000	3941.1716	43.500000	344.77909
10.000000	13154.014	27.000000	3759.4225	44.000000	332.64929
10.500000	12962.892	27.500000	3640.3973	44.500000	319.57292
11.000000	12678.705	28.000000	3505.2441	45.000000	326.50355
11.500000	12444.200	28.500000	3406.6767	45.500000	311.08270
12.000000	12302.952	29.000000	3296.4223	46.000000	162.69886
12.500000	12076.985	29.500000	3187.1056	46.500000	.00000000E+00
13.000000	11767.442	30.000000	3075.6346	47.000000	.00000000E+00
13.500000	11522.834	30.500000	2949.2036	47.500000	.00000000E+00
14.000000	11266.016	31.000000	2849.3856	48.000000	.00000000E+00
14.500000	10969.547	31.500000	2745.9361	48.500000	.00000000E+00
15.000000	10679.872	32.000000	2653.0804	49.000000	.00000000E+00
15.500000	10411.540	32.500000	2511.2582	49.500000	.00000000E+00
16.000000	9982.0631	33.000000	2423.9924	50.000000	.00000000E+00
16.500000	9705.0740	33.500000	2350.0660	.00000000E+00	.00000000E+00

FUEL SURFACE AREA---SLOT REGION NUMBER ONE---SQUARE INCHES

.00000000E+00	14062.054	17.000000	16266.213	34.000000	6958.7594
.50000000	14099.219	17.500000	16034.568	34.500000	6617.2297
1.0000000	14297.136	18.000000	15805.725	35.000000	6273.5375
1.5000000	14493.521	18.500000	15578.287	35.500000	5927.6148
2.0000000	14688.375	19.000000	15351.199	36.000000	5579.3993
2.5000000	14881.698	19.500000	15123.644	36.500000	5228.8340
3.0000000	15073.489	20.000000	14894.984	37.000000	4875.8660
3.5000000	15263.749	20.500000	14664.706	37.500000	4520.4470
4.0000000	15452.478	21.000000	14432.395	38.000000	4162.5320
4.5000000	15639.675	21.500000	14197.710	38.500000	3802.0797
5.0000000	15825.341	22.000000	13960.370	39.000000	3439.0517
5.5000000	16009.476	22.500000	13720.138	39.500000	3073.4100
6.0000000	16192.079	23.000000	13476.816	40.000000	2705.1254
6.5000000	16373.151	23.500000	13230.235	40.500000	2334.1673
7.0000000	16552.692	24.000000	12980.250	41.000000	1960.5072
7.5000000	16730.701	24.500000	12669.045	41.500000	1584.1189
8.0000000	16907.179	25.000000	12457.642	42.000000	1204.9781
8.5000000	17082.126	25.500000	12208.126	42.500000	823.06362
9.0000000	17255.542	26.000000	11954.106	43.000000	438.36203
9.5000000	17427.426	26.500000	11698.117	43.500000	51.083702
10.000000	17597.779	27.000000	11440.596	44.000000	.00000000E+00
10.500000	17766.600	27.500000	11181.595	44.500000	.00000000E+00
11.000000	17933.890	28.000000	10921.061	45.000000	.00000000E+00
11.500000	18099.649	28.500000	10600.343	45.500000	.00000000E+00
12.000000	18263.877	29.000000	10275.656	46.000000	.00000000E+00
12.500000	18426.573	29.500000	9950.1870	46.500000	.00000000E+00
13.000000	18587.738	30.000000	9623.7398	47.000000	.00000000E+00
13.500000	18368.902	30.500000	9296.1352	47.500000	.00000000E+00
14.000000	17922.896	31.000000	8967.2121	48.000000	.00000000E+00
14.500000	17574.326	31.500000	8636.8255	48.500000	.00000000E+00
15.000000	17273.871	32.000000	8304.8442	49.000000	.00000000E+00
15.500000	17001.342	32.500000	7971.1497	49.500000	.00000000E+00
16.000000	16746.289	33.000000	7635.6343	50.000000	.00000000E+00
16.500000	16502.560	33.500000	7298.2005	.00000000E+00	.00000000E+00

FUEL SURFACE AREA--1ST SEGMENT CP REGION--SQUARE INCHES

.00000000E+00	51431.153	17.000000	78207.430	34.000000	102620.75
.50000000	52252.421	17.500000	78959.195	34.500000	103303.03
1.0000000	53071.645	18.000000	79708.916	35.000000	103983.25
1.5000000	53888.825	18.500000	80456.593	35.500000	104661.44
2.0000000	54703.960	19.000000	81202.225	36.000000	105337.58
2.5000000	55517.050	19.500000	81945.814	36.500000	106011.67
3.0000000	56328.097	20.000000	82687.358	37.000000	106683.72
3.5000000	57137.098	20.500000	83426.859	37.500000	107353.73
4.0000000	57944.056	21.000000	84164.315	38.000000	108021.70
4.5000000	58748.969	21.500000	84899.728	38.500000	108687.62
5.0000000	59551.838	22.000000	85633.096	39.000000	109351.50
5.5000000	60352.663	22.500000	86364.421	39.500000	110013.32
6.0000000	61151.443	23.000000	87093.701	40.000000	110673.10
6.5000000	61948.179	23.500000	87820.938	40.500000	111330.83
7.0000000	62742.871	24.000000	88546.130	41.000000	111986.52
7.5000000	63535.518	24.500000	89269.278	41.500000	112640.17
8.0000000	64326.122	25.000000	89990.383	42.000000	113291.77
8.5000000	65114.681	25.500000	90709.444	42.500000	113941.33
9.0000000	65901.196	26.000000	91426.460	43.000000	114588.85
9.5000000	66685.666	26.500000	92141.433	43.500000	115234.32
10.000000	67468.093	27.000000	92854.361	44.000000	110922.40
10.500000	68248.475	27.500000	93565.246	44.500000	84088.572
11.000000	69026.813	28.000000	94274.087	45.000000	56904.102
11.500000	69803.108	28.500000	94980.884	45.500000	29563.493
12.000000	70577.357	29.000000	95685.637	46.000000	2700.8025
12.500000	71349.563	29.500000	96388.346	46.500000	.00000000E+00
13.000000	72119.725	30.000000	97089.011	47.000000	.00000000E+00
13.500000	72887.842	30.500000	97787.633	47.500000	.00000000E+00
14.000000	73653.916	31.000000	98484.210	48.000000	.00000000E+00
14.500000	74417.945	31.500000	99178.744	48.500000	.00000000E+00
15.000000	75179.930	32.000000	99871.234	49.000000	.00000000E+00
15.500000	75939.871	32.500000	100561.68	49.500000	.00000000E+00
16.000000	76697.769	33.000000	101250.08	50.000000	.00000000E+00
16.500000	77453.621	33.500000	101936.44	.00000000E+00	.00000000E+00

COLUMN #5 ON THE PLOT FILE V06+V07+V08+V09

.00000000E+00	243302.46	17.000000	124945.97	34.000000	111856.16
.50000000	244157.25	17.500000	120036.90	34.500000	112102.70
1.0000000	245228.21	18.000000	115787.75	35.000000	112315.03
1.5000000	246344.35	18.500000	112023.86	35.500000	112727.75
2.0000000	247471.48	19.000000	108421.14	36.000000	113230.87
2.5000000	248574.11	19.500000	105264.37	36.500000	113221.14
3.0000000	249145.62	20.000000	104135.98	37.000000	112887.31
3.5000000	248545.94	20.500000	104634.23	37.500000	112974.49
4.0000000	246883.70	21.000000	104725.31	38.000000	112786.98
4.5000000	244787.45	21.500000	104906.94	38.500000	113898.07
5.0000000	242695.25	22.000000	105092.33	39.000000	113245.78
5.5000000	240911.08	22.500000	105335.03	39.500000	113535.12
6.0000000	239859.05	23.000000	105597.78	40.000000	113819.31
6.5000000	239583.31	23.500000	105871.69	40.500000	114098.30
7.0000000	240116.94	24.000000	106173.27	41.000000	114372.00
7.5000000	235317.02	24.500000	106414.12	41.500000	114655.05
8.0000000	224815.23	25.000000	106795.51	42.000000	114918.89
8.5000000	217948.21	25.500000	107101.58	42.500000	115177.28
9.0000000	211797.37	26.000000	107437.99	43.000000	115383.49
9.5000000	206101.85	26.500000	107780.72	43.500000	115630.18
10.000000	200642.65	27.000000	108054.38	44.000000	111255.05
10.500000	195284.90	27.500000	108387.24	44.500000	84408.145
11.000000	189930.68	28.000000	108700.39	45.000000	57230.606
11.500000	184696.62	28.500000	108987.90	45.500000	29874.576
12.000000	179608.94	29.000000	109257.71	46.000000	2863.5014
12.500000	174477.54	29.500000	109525.64	46.500000	.00000000E+00
13.000000	169294.86	30.000000	109788.39	47.000000	.00000000E+00
13.500000	163824.44	30.500000	110032.97	47.500000	.00000000E+00
14.000000	158137.05	31.000000	110300.81	48.000000	.00000000E+00
14.500000	152526.04	31.500000	110561.51	48.500000	.00000000E+00
15.000000	146985.55	32.000000	110829.16	49.000000	.00000000E+00
15.500000	141507.52	32.500000	111044.09	49.500000	.00000000E+00
16.000000	135897.10	33.000000	111309.71	50.000000	.00000000E+00
16.500000	130460.19	33.500000	111584.71	.00000000E+00	.00000000E+00

FUEL SURFACE AREA--2ND SEGMENT CP REGION--SQUARE INCHES

.00000000E+00	81747.473	17.000000	128690.29	34.000000	175633.10
.50000000	83128.144	17.500000	130070.96	34.500000	177013.78
1.0000000	84508.815	18.000000	131451.63	35.000000	178394.45
1.5000000	85889.486	18.500000	132832.30	35.500000	179775.12
2.0000000	87270.157	19.000000	134212.97	36.000000	181155.79
2.5000000	88650.828	19.500000	135593.64	36.500000	182536.46
3.0000000	90031.499	20.000000	136974.31	37.000000	183917.13
3.5000000	91412.170	20.500000	138354.99	37.500000	185297.80
4.0000000	92792.841	21.000000	139735.66	38.000000	186678.47
4.5000000	94173.512	21.500000	141116.33	38.500000	188059.14
5.0000000	95554.183	22.000000	142497.00	39.000000	189439.81
5.5000000	96934.854	22.500000	143877.67	39.500000	190820.49
6.0000000	98315.525	23.000000	145258.34	40.000000	192201.16
6.5000000	99696.196	23.500000	146639.01	40.500000	193581.83
7.0000000	101076.87	24.000000	148019.68	41.000000	194962.50
7.5000000	102457.54	24.500000	149400.35	41.500000	196343.17
8.0000000	103838.21	25.000000	150781.03	42.000000	197723.84
8.5000000	105218.88	25.500000	152161.70	42.500000	198767.66
9.0000000	106599.55	26.000000	153542.37	43.000000	198868.81
9.5000000	107980.22	26.500000	154923.04	43.500000	182289.18
10.000000	109360.89	27.000000	156303.71	44.000000	149978.52
10.500000	110741.56	27.500000	157684.38	44.500000	116158.91
11.000000	112122.24	28.000000	159065.05	45.000000	81169.272
11.500000	113502.91	28.500000	160445.72	45.500000	45817.656
12.000000	114883.58	29.000000	161826.39	46.000000	.00000000E+00
12.500000	116264.25	29.500000	163207.06	46.500000	.00000000E+00
13.000000	117644.92	30.000000	164587.74	47.000000	.00000000E+00
13.500000	119025.59	30.500000	165968.41	47.500000	.00000000E+00
14.000000	120406.26	31.000000	167349.08	48.000000	.00000000E+00
14.500000	121786.93	31.500000	168729.75	48.500000	.00000000E+00
15.000000	123167.60	32.000000	170110.42	49.000000	.00000000E+00
15.500000	124548.28	32.500000	171491.09	49.500000	.00000000E+00
16.000000	125928.95	33.000000	172871.76	50.000000	.00000000E+00
16.500000	127309.62	33.500000	174252.43	.00000000E+00	.00000000E+00

FUEL SURFACE AREA--SLOT REGION NUMBER TWO--SQUARE INCHES

.00000000E+00	13957.780	17.000000	15996.114	34.000000	6512.9831
.50000000	13989.051	17.500000	15760.607	34.500000	6167.4617
1.0000000	14181.065	18.000000	15527.805	35.000000	5819.7715
1.5000000	14371.538	18.500000	15296.331	35.500000	5469.8449
2.0000000	14560.472	19.000000	15065.148	36.000000	5117.6201
2.5000000	14747.867	19.500000	14833.451	36.500000	4763.0400
3.0000000	14933.721	20.000000	14600.610	37.000000	4406.0524
3.5000000	15118.036	20.500000	14366.117	37.500000	4046.6090
4.0000000	15300.811	21.000000	14129.563	38.000000	3684.6654
4.5000000	15482.046	21.500000	13890.612	38.500000	3320.1805
5.0000000	15661.741	22.000000	13648.984	39.000000	2953.1160
5.5000000	15839.896	22.500000	13404.446	39.500000	2583.4369
6.0000000	16016.512	23.000000	13156.802	40.000000	2211.1103
6.5000000	16191.588	23.500000	12905.884	40.500000	1836.1059
7.0000000	16365.124	24.000000	12627.045	41.000000	1458.3953
7.5000000	16537.120	24.500000	12389.302	41.500000	1077.9523
8.0000000	16707.577	25.000000	12136.724	42.000000	694.75243
8.5000000	16876.494	25.500000	11881.889	42.500000	308.77400
9.0000000	17043.871	26.000000	11625.748	43.000000	.00000000E+00
9.5000000	17209.708	26.500000	11368.396	43.500000	.00000000E+00
10.000000	17374.005	27.000000	11109.761	44.000000	.00000000E+00
10.500000	17536.763	27.500000	10849.732	44.500000	.00000000E+00
11.000000	17697.980	28.000000	10526.202	45.000000	.00000000E+00
11.500000	17857.659	28.500000	10198.104	45.500000	.00000000E+00
12.000000	18015.796	29.000000	9869.4648	46.000000	.00000000E+00
12.500000	18172.395	29.500000	9540.0530	46.500000	.00000000E+00
13.000000	18327.454	30.000000	9209.6647	47.000000	.00000000E+00
13.500000	18111.744	30.500000	8878.1172	47.500000	.00000000E+00
14.000000	17669.057	31.000000	8545.2474	48.000000	.00000000E+00
14.500000	17319.802	31.500000	8210.9086	48.500000	.00000000E+00
15.000000	17017.204	32.000000	7874.9689	49.000000	.00000000E+00
15.500000	16741.808	32.500000	7537.3093	49.500000	.00000000E+00
16.000000	16483.472	33.000000	7197.8221	50.000000	.00000000E+00
16.500000	16236.192	33.500000	6856.4096	.00000000E+00	.00000000E+00

COLUMN #6 ON THE PLOT FILE V16+V17

.00000000E+00	95705.253	17.000000	144686.40	34.000000	182146.09
.50000000	97117.195	17.500000	145831.57	34.500000	183181.24
1.0000000	98689.879	18.000000	146979.44	35.000000	184214.22
1.5000000	100261.02	18.500000	148128.63	35.500000	185244.96
2.0000000	101830.63	19.000000	149278.12	36.000000	186273.41
2.5000000	103398.69	19.500000	150427.09	36.500000	187299.50
3.0000000	104965.22	20.000000	151574.92	37.000000	188323.18
3.5000000	106530.21	20.500000	152721.10	37.500000	189344.41
4.0000000	108093.65	21.000000	153865.22	38.000000	190363.14
4.5000000	109655.56	21.500000	155006.94	38.500000	191379.32
5.0000000	111215.92	22.000000	156145.98	39.000000	192392.93
5.5000000	112774.75	22.500000	157282.12	39.500000	193403.92
6.0000000	114332.04	23.000000	158415.14	40.000000	194412.27
6.5000000	115887.78	23.500000	159544.90	40.500000	195417.93
7.0000000	117441.99	24.000000	160646.73	41.000000	196420.89
7.5000000	118994.66	24.500000	161789.66	41.500000	197421.12
8.0000000	120545.79	25.000000	162917.75	42.000000	198418.59
8.5000000	122095.37	25.500000	164043.59	42.500000	199076.44
9.0000000	123643.42	26.000000	165168.12	43.000000	198868.81
9.5000000	125189.93	26.500000	166291.43	43.500000	182289.18
10.000000	126734.90	27.000000	167413.47	44.000000	149978.52
10.500000	128278.33	27.500000	168534.11	44.500000	116158.91
11.000000	129820.22	28.000000	169591.25	45.000000	81169.272
11.500000	131360.57	28.500000	170643.83	45.500000	45817.656
12.000000	132899.37	29.000000	171695.86	46.000000	.00000000E+00
12.500000	134436.64	29.500000	172747.12	46.500000	.00000000E+00
13.000000	135972.37	30.000000	173797.40	47.000000	.00000000E+00
13.500000	137137.34	30.500000	174846.52	47.500000	.00000000E+00
14.000000	138075.32	31.000000	175894.33	48.000000	.00000000E+00
14.500000	139106.74	31.500000	176940.66	48.500000	.00000000E+00
15.000000	140184.81	32.000000	177985.39	49.000000	.00000000E+00
15.500000	141290.08	32.500000	179028.40	49.500000	.00000000E+00
16.000000	142412.42	33.000000	180069.58	50.000000	.00000000E+00
16.500000	143545.81	33.500000	181108.84	.00000000E+00	.00000000E+00

FUEL SURFACE AREA--3RD SEGMENT CP REGION--SQUARE INCHES

.00000000E+00	72126.061	17.000000	106921.31	34.000000	110150.45
.50000000	73148.188	17.500000	107946.09	34.500000	106901.50
1.0000000	74170.380	18.000000	108970.95	35.000000	103622.97
1.5000000	75192.639	18.500000	109995.88	35.500000	100314.84
2.0000000	76214.967	19.000000	111020.87	36.000000	96977.119
2.5000000	77237.366	19.500000	112045.94	36.500000	93609.808
3.0000000	78259.837	20.000000	113071.07	37.000000	90212.906
3.5000000	79282.380	20.500000	114096.27	37.500000	86786.413
4.0000000	80304.999	21.000000	115121.53	38.000000	83330.328
4.5000000	81327.692	21.500000	116146.85	38.500000	79847.249
5.0000000	82350.463	22.000000	117172.23	39.000000	76335.953
5.5000000	83373.312	22.500000	118197.68	39.500000	72696.775
6.0000000	84396.239	23.000000	119223.17	40.000000	68735.857
6.5000000	85419.246	23.500000	120248.73	40.500000	64739.839
7.0000000	86442.334	24.000000	121274.33	41.000000	60708.721
7.5000000	87465.503	24.500000	122299.99	41.500000	56642.502
8.0000000	88488.753	25.000000	123325.70	42.000000	52541.184
8.5000000	89512.086	25.500000	124351.45	42.500000	48404.765
9.0000000	90535.502	26.000000	125377.25	43.000000	44233.246
9.5000000	91559.000	26.500000	126403.09	43.500000	.00000000E+00
10.000000	92582.582	27.000000	127428.97	44.000000	.00000000E+00
10.500000	93606.246	27.500000	128454.90	44.500000	.00000000E+00
11.000000	94629.994	28.000000	129480.86	45.000000	.00000000E+00
11.500000	95653.825	28.500000	130506.85	45.500000	.00000000E+00
12.000000	96677.739	29.000000	131532.88	46.000000	.00000000E+00
12.500000	97701.735	29.500000	132558.95	46.500000	.00000000E+00
13.000000	98725.813	30.000000	133254.68	47.000000	.00000000E+00
13.500000	99749.973	30.500000	133881.89	47.500000	.00000000E+00
14.000000	100774.21	31.000000	134506.34	48.000000	.00000000E+00
14.500000	101798.53	31.500000	130743.17	48.500000	.00000000E+00
15.000000	102822.94	32.000000	126641.84	49.000000	.00000000E+00
15.500000	103847.41	32.500000	122362.66	49.500000	.00000000E+00
16.000000	104871.97	33.000000	117870.18	50.000000	.00000000E+00
16.500000	105896.60	33.500000	113369.97	.00000000E+00	.00000000E+00

COLUMN #7 ON THE PLOT FILE V18+V19

.00000000E+00	72126.061	17.000000	106921.31	34.000000	110150.45
.50000000	73148.188	17.500000	107946.09	34.500000	106901.50
1.0000000	74170.380	18.000000	108970.95	35.000000	103622.97
1.5000000	75192.639	18.500000	109995.88	35.500000	100314.84
2.0000000	76214.967	19.000000	111020.87	36.000000	96977.119
2.5000000	77237.366	19.500000	112045.94	36.500000	93609.808
3.0000000	78259.837	20.000000	113071.07	37.000000	90212.906
3.5000000	79282.380	20.500000	114096.27	37.500000	86786.413
4.0000000	80304.999	21.000000	115121.53	38.000000	83330.328
4.5000000	81327.692	21.500000	116146.85	38.500000	79847.249
5.0000000	82350.463	22.000000	117172.23	39.000000	76335.953
5.5000000	83373.312	22.500000	118197.68	39.500000	72696.775
6.0000000	84396.239	23.000000	119223.17	40.000000	68735.857
6.5000000	85419.246	23.500000	120248.73	40.500000	64739.839
7.0000000	86442.334	24.000000	121274.33	41.000000	60708.721
7.5000000	87465.503	24.500000	122299.99	41.500000	56642.502
8.0000000	88488.753	25.000000	123325.70	42.000000	52541.184
8.5000000	89512.086	25.500000	124351.45	42.500000	48404.765
9.0000000	90535.502	26.000000	125377.25	43.000000	44233.246
9.5000000	91559.000	26.500000	126403.09	43.500000	.00000000E+00
10.000000	92582.582	27.000000	127428.97	44.000000	.00000000E+00
10.500000	93606.246	27.500000	128454.90	44.500000	.00000000E+00
11.000000	94629.994	28.000000	129480.86	45.000000	.00000000E+00
11.500000	95653.825	28.500000	130506.85	45.500000	.00000000E+00
12.000000	96677.739	29.000000	131532.88	46.000000	.00000000E+00
12.500000	97701.735	29.500000	132558.95	46.500000	.00000000E+00
13.000000	98725.813	30.000000	133254.68	47.000000	.00000000E+00
13.500000	99749.973	30.500000	133881.89	47.500000	.00000000E+00
14.000000	100774.21	31.000000	134506.34	48.000000	.00000000E+00
14.500000	101798.53	31.500000	130743.17	48.500000	.00000000E+00
15.000000	102822.94	32.000000	126641.84	49.000000	.00000000E+00
15.500000	103847.41	32.500000	122362.66	49.500000	.00000000E+00
16.000000	104871.97	33.000000	117870.18	50.000000	.00000000E+00
16.500000	105896.60	33.500000	113369.97	.00000000E+00	.00000000E+00

AFT END BURN AREA---TOTAL---SQUARE INCHES

.00000000E+00	13993.154	17.000000	8350.8078	34.000000	.00000000E+00
.50000000	14116.825	17.500000	7589.9191	34.500000	.00000000E+00
1.0000000	14243.690	18.000000	6817.8384	35.000000	.00000000E+00
1.5000000	14262.052	18.500000	6034.5611	35.500000	.00000000E+00
2.0000000	14269.401	19.000000	5256.5363	36.000000	.00000000E+00
2.5000000	14276.725	19.500000	4583.1391	36.500000	.00000000E+00
3.0000000	14285.462	20.000000	3900.2303	37.000000	.00000000E+00
3.5000000	14292.754	20.500000	3599.1596	37.500000	.00000000E+00
4.0000000	14215.856	21.000000	3322.3480	38.000000	.00000000E+00
4.5000000	14125.370	21.500000	4333.2754	38.500000	.00000000E+00
5.0000000	14031.805	22.000000	4077.5306	39.000000	.00000000E+00
5.5000000	13935.134	22.500000	3827.1547	39.500000	.00000000E+00
6.0000000	13835.333	23.000000	3581.5866	40.000000	.00000000E+00
6.5000000	13734.186	23.500000	3333.7506	40.500000	.00000000E+00
7.0000000	13635.452	24.000000	3083.6468	41.000000	.00000000E+00
7.5000000	13533.637	24.500000	2831.2753	41.500000	.00000000E+00
8.0000000	13428.720	25.000000	2576.6359	42.000000	.00000000E+00
8.5000000	13320.685	25.500000	2319.7286	42.500000	.00000000E+00
9.0000000	13209.513	26.000000	2060.5536	43.000000	.00000000E+00
9.5000000	13095.190	26.500000	1799.1107	43.500000	.00000000E+00
10.000000	12977.700	27.000000	1535.4000	44.000000	.00000000E+00
10.500000	12819.423	27.500000	1271.8657	44.500000	.00000000E+00
11.000000	12654.992	28.000000	986.01372	45.000000	.00000000E+00
11.500000	12477.887	28.500000	691.31678	45.500000	.00000000E+00
12.000000	12278.061	29.000000	393.63757	46.000000	.00000000E+00
12.500000	12074.025	29.500000	56.383926	46.500000	.00000000E+00
13.000000	11865.769	30.000000	.00000000E+00	47.000000	.00000000E+00
13.500000	11625.025	30.500000	.00000000E+00	47.500000	.00000000E+00
14.000000	11333.930	31.000000	.00000000E+00	48.000000	.00000000E+00
14.500000	11037.579	31.500000	.00000000E+00	48.500000	.00000000E+00
15.000000	10676.280	32.000000	.00000000E+00	49.000000	.00000000E+00
15.500000	10215.364	32.500000	.00000000E+00	49.500000	.00000000E+00
16.000000	9668.8664	33.000000	.00000000E+00	50.000000	.00000000E+00
16.500000	9025.2010	33.500000	.00000000E+00	.00000000E+00	.00000000E+00

COLUMN #8 ON THE PLOT FILE V20+V21+V30

.00000000E+00	13993.154	17.000000	8350.8078	34.000000	.00000000E+00
.50000000	14116.825	17.500000	7589.9191	34.500000	.00000000E+00
1.0000000	14243.690	18.000000	6817.8384	35.000000	.00000000E+00
1.5000000	14262.052	18.500000	6034.5611	35.500000	.00000000E+00
2.0000000	14269.401	19.000000	5256.5363	36.000000	.00000000E+00
2.5000000	14276.725	19.500000	4583.1391	36.500000	.00000000E+00
3.0000000	14285.462	20.000000	3900.2303	37.000000	.00000000E+00
3.5000000	14292.754	20.500000	3599.1596	37.500000	.00000000E+00
4.0000000	14215.856	21.000000	3322.3480	38.000000	.00000000E+00
4.5000000	14125.370	21.500000	4333.2754	38.500000	.00000000E+00
5.0000000	14031.805	22.000000	4077.5306	39.000000	.00000000E+00
5.5000000	13935.134	22.500000	3827.1547	39.500000	.00000000E+00
6.0000000	13835.333	23.000000	3581.5866	40.000000	.00000000E+00
6.5000000	13734.186	23.500000	3333.7506	40.500000	.00000000E+00
7.0000000	13635.452	24.000000	3083.6468	41.000000	.00000000E+00
7.5000000	13533.637	24.500000	2831.2753	41.500000	.00000000E+00
8.0000000	13428.720	25.000000	2576.6359	42.000000	.00000000E+00
8.5000000	13320.685	25.500000	2319.7286	42.500000	.00000000E+00
9.0000000	13209.513	26.000000	2060.5536	43.000000	.00000000E+00
9.5000000	13095.190	26.500000	1799.1107	43.500000	.00000000E+00
10.000000	12977.700	27.000000	1535.4000	44.000000	.00000000E+00
10.500000	12819.423	27.500000	1271.8657	44.500000	.00000000E+00
11.000000	12654.992	28.000000	986.01372	45.000000	.00000000E+00
11.500000	12477.887	28.500000	691.31678	45.500000	.00000000E+00
12.000000	12278.061	29.000000	393.63757	46.000000	.00000000E+00
12.500000	12074.025	29.500000	56.383926	46.500000	.00000000E+00
13.000000	11865.769	30.000000	.00000000E+00	47.000000	.00000000E+00
13.500000	11625.025	30.500000	.00000000E+00	47.500000	.00000000E+00
14.000000	11333.930	31.000000	.00000000E+00	48.000000	.00000000E+00
14.500000	11037.579	31.500000	.00000000E+00	48.500000	.00000000E+00
15.000000	10676.280	32.000000	.00000000E+00	49.000000	.00000000E+00
15.500000	10215.364	32.500000	.00000000E+00	49.500000	.00000000E+00
16.000000	9668.8664	33.000000	.00000000E+00	50.000000	.00000000E+00
16.500000	9025.2010	33.500000	.00000000E+00	.00000000E+00	.00000000E+00

*** END PROGRAM CBRM ***